VOLUME 84, No. 11

STEAM GENERATION
POWER GENERATION
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NOVEMBER, 1940

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A McGRAW-HILL PUBLICATION

Publication office: 99-129 North Broadway, Albany, N. Y.
Editorial & Executive Offices: 330 West 42nd St., New York, N. Y.

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CHICAGO, 520 North Michigan Ave.
SAN FRANCISCO, 68 Post St.
WASHINGTON, National Press Bldg.
PHILADELPHIA, 16 South Broad St.
CLEVELAND, 1510 Hanna Bldg.
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ATLANTA, 1011 Rhodes Haverty Bldg.
LONDON, Aldwych House, Aldwych, London, W C.2

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POWER articles are currently indexed in both the Industrial Arts and the Engineering Indexes, available at public libraries. Also every year POWER issues an annual index of its own. Cable Address: "McGraw-Hill, N. Y."

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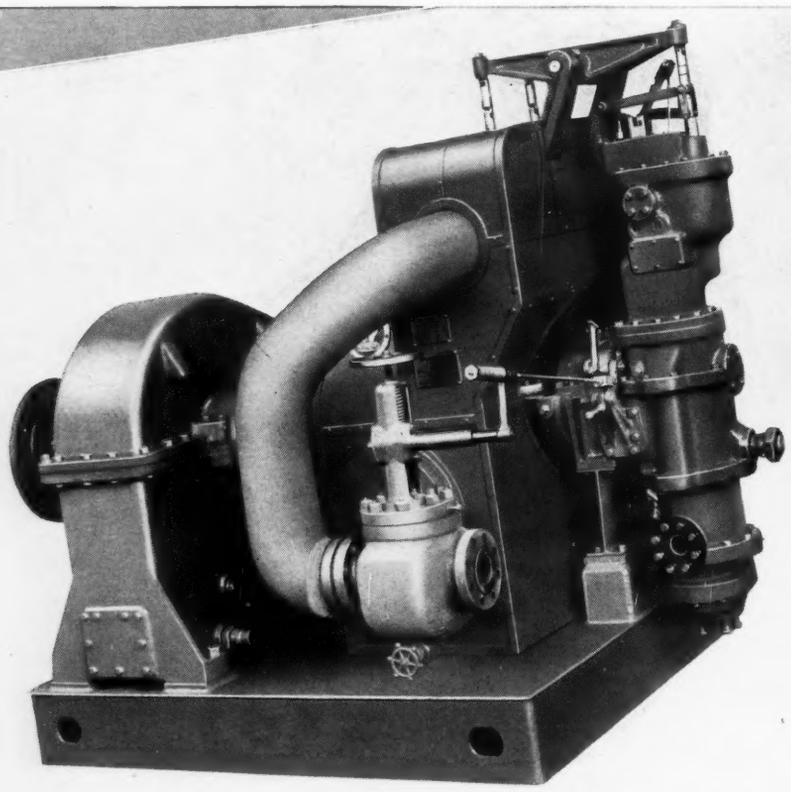

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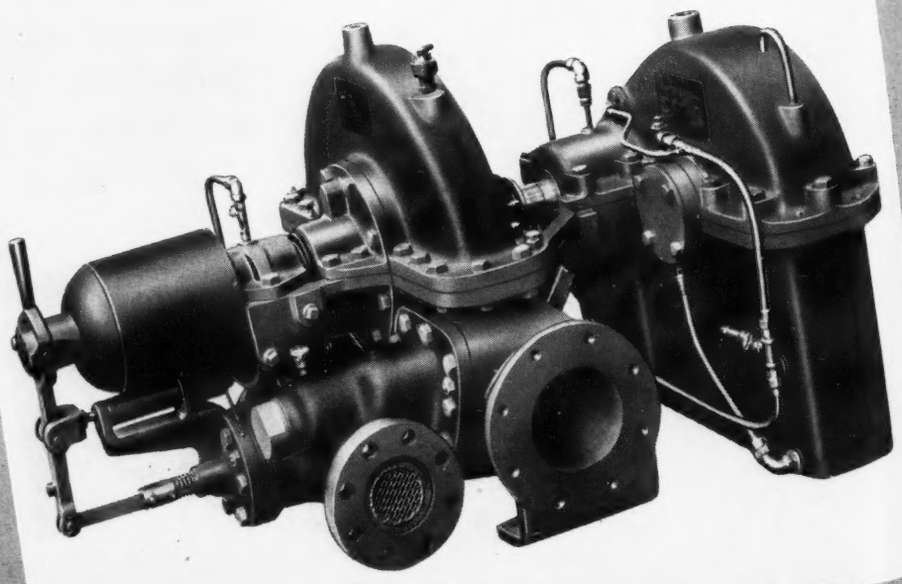

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A Power Engineer Looks at the Defense Program

By PHILIP SWAIN, Editor

Because the nation's defense effort is at last "beginning to roll", we review latest developments and show how they affect the power picture and the power engineer

Total defense appropriations exceed 15 billion dollars. Spending of this money will mean big increases in the power and steam loads of the heavy industries. The bigger payrolls created will feed back into the consumer market in turn, raising the rate of operation, and the power-service demands, of many "non-defense" industries

► FOR THE FIRST TIME IN HISTORY, America is systematically preparing for a war while she is still at peace. If we entered the first World War with some industrial preparation, the credit must go to luck rather than to national planning. The defense plants, tools and experience available when America declared war in 1917 were merely a by-product of the orders placed here by the Allies in the three preceding years.

After America, this spring, decided on a major defense effort, many precious weeks were lost in the debate over "amortization." Quite naturally manufacturers didn't want to pay for enormous additions to their plants (buildings, machines and tools), then pay heavy taxes on this investment, and, finally, with peace restored, find themselves loaded with useless facilities.

Financing Defense Plants

This difficulty has now been removed by the establishment of three alternative plans for financing defense plants:

1—Where the plant is for war purposes only (as, for example, a powder plant) the government will build and own the plant, hire industry to run it.

2—Where a new plant or extension, required for defense, has some peacetime value, the manufacturer may build it with his own money, but amortize it at the rate of 20% yearly, thus saving on taxes.

3—Or the manufacturer may finance the new plant or extension under an arrangement whereby the government agrees to buy back the plant in installments—20% yearly. At the end of five years the government will own the plant, but the manufacturer will have an option to repurchase at depreciated value.

These three plans, now in operation, have cleared the way for action. From now on, the nation's production *plant* will grow fast. Power and steam facilities serving industry must keep pace.

How about delays in getting the final defense *results*—ships in the water, tanks in the field, planes in the air? Here the public must be educated not to expect miracles. It must learn that the plans for a battleship weigh seven tons, those for a tank 200 lb—that buildings must be erected, production machines built, tools made long before the first unit rolls out.

Conscription

The calling out of the National Guard, and the recent nationwide registration of manpower following passage of the conscription bill, open the road for mass training of soldiers as soon as the necessary cantonments can be built and essential supplies and equipment secured. The army is wasting no time here. Cantonments mean heating systems, boilers and piping, hence added load on the producers of such equipment. Soldiers' blankets and uniforms must be provided by the textile industry and these will take their share of power and steam.

Army and Navy expenditures were about $225,000,000 in September, 1940. With the National Guard mobilization and conscription now "in the works," this monthly figure will rise rapidly. Moreover, the government's industrial expenditures will skyrocket as the new defense plants get into construction and production.

Defense Appropriations

Total defense appropriations, now exceeding 15 billion dollars, will soon rise to 20 billions. Experts estimate that actual expenditures for defense will average ten billions yearly as long as the emergency continues and we are *not* at war. To this staggering sum add all the "normal" governmental expenditures.

Spending of this money will mean big increases in the power and steam loads of the heavy industries. The bigger payrolls created will feed back into the consumer markets in turn, raising the rate of operation, and the

Plans for a battleship weigh seven tons, those for a tank 200 lb, which explains in part why the ocean doesn't fill up with battlewagons and the roads with tanks the morning after orders are placed. These defense machines are now "in the works", but it will take years to produce an ample supply

power-service demands, of many "non-defense" industries.

What is a defense plant? Obviously, it is a powder factory, a shell-loading plant, a yard for battleships, a tank factory. It is also whatever portion of a "peace-time" plant may be required to produce food, clothing, tools, machines, buildings and supplies for defense purposes. To some extent, almost every industry will become a defense industry. The automobile industry, for example, will produce thousands of cars and trucks for the Army, as well as such strictly military items as tanks and airplane motors.

Power for Powder Plants

For war purposes only, more than $500,000,000 will be spent directly by the government to build about 25 powder plants "between the mountains," far from danger of attack by planes based on the seaboard.

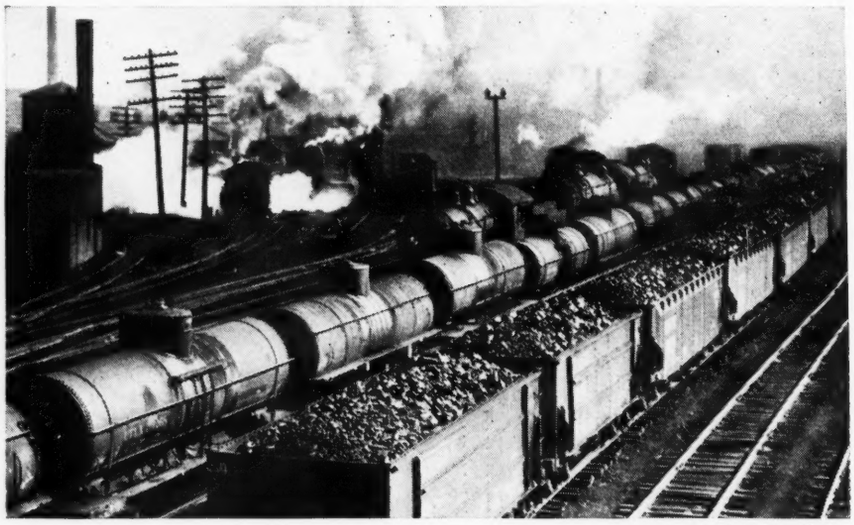
It is understood that each of these powder plants will have its own complete power plant for the generation of steam and by-product power.

Aviation is building and tooling for a tremendous defense effort. Unfilled orders on the books of the plane manufacturers now aggregate the stupendous sum of 2000 million dollars. Some 33,000 war planes (19,000 for the U. S. and 14,000 for Britain) are scheduled to be turned out before April 1, 1942. The industry has completed plans to triple its floor space.

The power demands of the aviation industry will grow in proportion, but most of the increase will be supplied from central stations.

Basically, railroads and coal are just as important to defense as planes, but will get less attention because the needed facilities are largely in hand, not merely on paper. No crisis in land transportation or fuel is expected. However, anticipating heavy traffic, the American Association of Railroads has advised its members to buy 100,000 freight cars between now and October, 1941.

Bituminous coal production for the past twelve months was 461 million tons, 25% higher than for the previous year. Further increases are easily attainable. Certainly enough coal can be mined to meet any steam requirements of the defense program.



Ewing Galloway Photo

Legally enforced schedules of minimum prices for bituminous coal became effective October 1. If the legislation works out, coal producers may make a little money for a change and power engineers will pay a little more for their coal, another incentive to eliminate wastes in generating and applying steam and electricity. Oil may rise in sympathy with coal as well as from other factors (see "Power for Defense", Sept, 1940)

Right now coal enters a unique situation stemming from the Bituminous Coal Act of 1937. The whole industry is to have price control under government sponsorship. (See page 90 for further details.) If the plan works, coal producers may make a little money for a change. Power engineers will pay a little more for their coal and find just that much more incentive to eliminate wastes in the generation and application of steam and electricity.

Labor

"Where there's smoke, there's fire." Plenty of substance lies behind the widespread talk of skilled-labor shortage. Both industry and governmental agencies are working hard to avoid a slowing down of the program for lack of enough skilled workers.

Plans include the "upgrading" of existing labor (with the help of special "refresher" courses) to higher-skill ratings, extension of apprentice training and recruiting, night shifts in vocational schools. Equally serious, but less talked of, is a possible shortage of able supervisors and technically trained men.

With the increased demand for skilled men in all trades, power supervisors in industry will find it worth while to hang onto their key men, in maintenance as well as operation, and to speed up the training of their younger helpers. Incidentally, shortage of man-power for production will accelerate the installation of labor-saving, power-consuming machinery.

The present upward trend of business

is so strongly established, and so firmly based on defense commitments, that it will continue regardless of election results or other factors that would normally affect it. The year 1941 is certain to show more business, more earnings (before taxes), more taxes and (we fear) somewhat higher prices.

The price rise may be modest, because both government and business leadership is acutely aware of the dangers of an inflationary upward spiral that might give the country a whirl of false prosperity and then, after the defense effort, leave it sitting in the dumps of 1920. Business men realize that any unjustified price increases will increase the cost of the defense program and thus increase taxes. It might bring out the "big stick" of priorities and government price control.

Power Equipment

It seems likely that the price of certain types of power equipment will rise somewhat to reflect increases in manufacturing cost. We hope the increases will be modest, but there is certainly no good reason, either in prices or deliveries, to delay ordering any equipment that will be needed to handle the loads of 1941 and 1942.

Heavy Industries Boom

The primary boom in the heavy industries is already reflected in payrolls and is therefore developing a secondary boom in consumer goods. Thus, for the immediate future at least, standards of living will rise. For the next six or nine months the national income will run at the rate of $80,000,000,000 per year. If this is adjusted to today's lower prices, it is more than equivalent, in purchasing power, to the national income of 1929, last year of the "big boom."

If all of our people had been employed at full efficiency prior to the defense program we would now face the European choice "guns versus comfortable living," since munitions could be produced only by reducing the number of workers producing consumer goods. In short, a defense program would necessarily mean fewer new cars, also less clothing, fewer new houses and luxuries, plainer eating.

Employment and payrolls are growing much faster than many realize—one recognized authority says unemployment will be practically wiped out by August, 1941. While this statement may be optimistic, it is a fact that in the power field, as every other, available labor will dwindle, the demand increase

Since many Americans were unemployed when the program started, it seems probable that the additional load of defense can be carried by employing more men and facilities without reducing the production of consumer goods or the American standard of living. This possibility has an appeal to our own wishes and many economists feel it would be best for the country. Their opinion is that consumer industries must be maintained to avoid a serious collapse after the defense emergency has passed.

In general, all industries will be fully employed. All will need a full supply of steam and power.

A word of warning is in order. When orders pile in fast there is a tendency to throw little economies overboard—to order by express what would come as well by freight, to pay too much for supplies, to do jobs on overtime that could (with planning) be done in regular time, to permit confused, unplanned operations. Big orders may not mean big profits under such management. Here is where every power engineer can serve by watching costs in his department.

POWER MAN'S SUMMARY OF DEFENSE

Summing up, the power man may expect the following from the defense situation:

1—Many new and enlarged plants to supply steam and power to defense factories, also added central-station loads to serve these.

2—A lot of low-pressure steam equipment supplied to cantonments.

3—Added loads in so-called "peace-time industries" (such as textiles) because of government orders.

4—Bigger power loads in the heavy industries.

5—Bigger power loads in the consumer industries.

6—25 enormous new powder plants, each with brand new steam and power facilities.

7—Big increase in power demand of plane manufacturers to be supplied mostly from the central stations.

8—Some increase in the price of coal. Certainty of enough mining capacity. Probability of adequate deliveries.

9—The need to hang onto key power operating and maintenance men and to train the youngsters.

10—General elimination of unemployment, accelerating the installation of labor-saving, power-consuming machines.

11—Some rise in the cost of power equipment, with possible lengthening of deliveries, making it wise to order at once, to take care of any possible load needs of 1941 or 1942.

12—Probable load increases even in the luxury industries.

13—Bigger orders reflected in bigger profits if wastes (including power wastes) don't eat them up.

Chester Station Adds 50,000-Kw Top

New 1250-lb, 925-F superposed turbine-generator and two 600,000-lb-per-hr boilers to be placed in operation early next year by Philadelphia Electric Co will lower station heat rate by approximately 6000 Btu per kwhr. Details also given on 80,000-kw condensing unit ordered for same plant

By D F SCHICK, Jr and C F BISHOP
Mechanical Engineering Div and Electrical Engineering Div

▶ THE CAPACITY of the Philadelphia Electric Co is furnished primarily by the stations indicated on the accompanying chart, Fig. 1. One major hydro plant and six steam generating stations provide a present system capacity of approximately 1,100,000 kw. Outstanding among the group are Conowingo Hydro Station, 58 miles from Philadelphia, with an installed capacity of 252,000 kw, the Richmond Steam Station which contains two 60,000-kw units and a 165,000-kw unit, the latter placed in operation in 1935, and Schuylkill Station in which a 50,000-kw superposed unit was installed during 1938.

The system is also interconnected with the neighboring Public Service Electric & Gas Co of New Jersey and the Pennsylvania Power and Light Co, forming a grid having a capacity of 2,500,000 hp, see Fig. 1.

Load Growth

On January 3, 1940, the Philadelphia Electric Co experienced and met the greatest of its demands, namely 910,000 kw. This demand figured on a conservative basis was well within the present capacity of the system. However, following a policy of long-range planning, additional capacity is now scheduled for installation which will adequately meet the expected load growth from domestic and industrial expansion throughout the area. There is now under construction in Chester Station a 50,000-kw superposed unit, and in addition, an 80,000-kw low-pressure turbine has been ordered for the same station. This will further reenforce the system and place the Philadelphia Electric Co in a position to meet almost any eventuality over the next few years.

A study of the net heat rates of the several stations over a period of years indicates a contribution toward economy in the reduction in fuel consumption per kwhr. The heat-rate curve is rapidly flattening out and further material reduction cannot be expected with present cycles. The Chester Station heat rate, formerly in the 17,500-Btu-per-kwhr range, will be reduced through the medium of superposition to approximately 11,600 Btu per kwhr with installation of the 50,000-kw unit. An even greater comparative reduction has already been experienced by superposition of a 50,000-kw unit at the older and less efficient Schuylkill Station.

Chester Station is on the Delaware River at Front and Ward Streets, Chester, Pa. Ground was originally broken for this station in 1916. The first units, No. 3 and No. 4, went into operation in 1918. In 1924, two more turbines, No. 1 and No. 2, were placed in operation to meet increased power demand in the Chester area. The present work is the first to involve any major construction in Chester Station since the 1924 installation. Thus, before superposition, four 250-lb, 600-F condensing turbine-generators (126,000 kw total) and 16 stoker-fired boilers comprised the station capacity. Fig. 2 shows the present structure and Fig. 3 the four original low-pressure units.

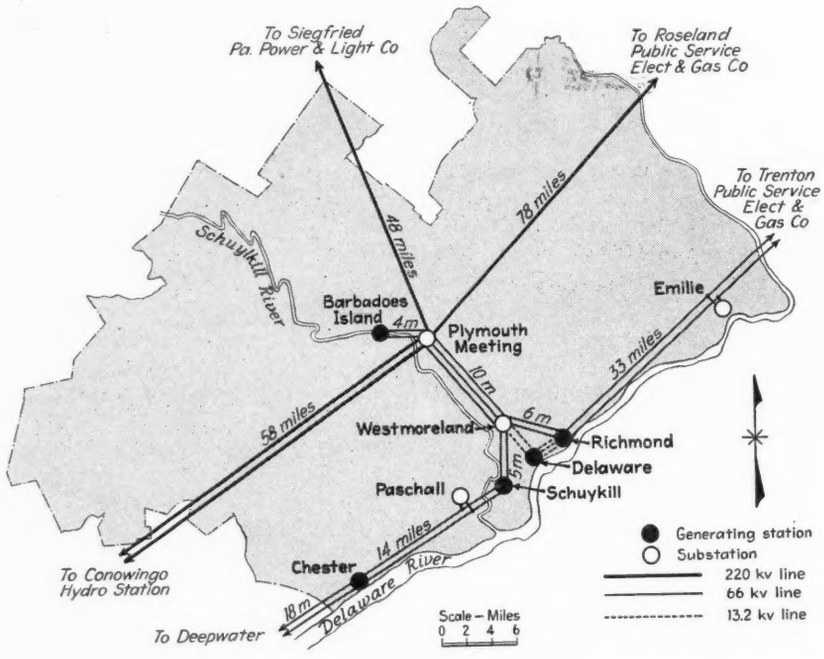


Fig. 1—Main transmission system and stations of the Philadelphia Electric Co

The general plan for increase in capacity and increase in economy at this location provided for the installation of one 50,000-kw turbine-generator and two 600,000-lb-per-hr pulverized-fuel boilers. Steam conditions at the new turbine are 1250 lb per sq in. pressure and 925 F total temperature.

Exhaust conditions of this turbine will approximate the steam conditions now existing in the station. Normally, the exhaust from the 50,000-kw unit will supply steam for three of the four present turbine-generators operating at their most efficient point. The new high-pressure turbine No. 5 is in an existing space in the present turbine hall between No. 2 and No. 3 low-pressure units. Four of the original 125,000-lb-per-hr stoker-fired

boilers have been removed to make space for two 600,000-lb-per-hr pulverized-fuel-fired boilers and their auxiliaries. This unit will go in operation early in 1941.

The next step in extending the station is the installation of an 80,000-kw, No. 6 low-pressure condensing unit which has already been ordered, and construction on this unit will start in the near future. No additional steam-generating capacity is required as exhaust steam from the 50,000-kw No. 5 unit and the remaining 12 low-pressure boilers is adequate to meet all low-pressure turbine demands. The 80,000-kw unit will be housed in an extension to the present turbine hall. This latter unit will be 59 ft long, 27 ft wide 16 ft high and will weigh approximately 1,200,000 lb. The extension will be approximately 150 ft long, 50 ft wide, and 80 ft high. With these installations the capacity of the station will be more than doubled. The operating rating of the 50,000-kw, 80%-pf machine will be 56,000 kw and that of the 80,000-kw, 80%-pf machine, 90,000 kw.

Topping Turbine

The superposed turbine will be rated at 50,000 kw, 3600 rpm, and is an 11-stage, 10-valve, impulse-type, single-cylinder, non-condensing unit with double-shell construction, see Fig. 4. This turbine can produce 56,250 kw at 90% pf on the generator. Steam conditions are 1250 lb per sq in. gage and 925 F total temperature at the inlet valves, with 265 lb per sq in. gage and 570 F total temperature exhaust at the 50,000-kw load point. The unit will be capable of operation with steam up to 1300 lb per sq in. gage and 950 F. This turbine can exhaust to any of the four existing turbines or to the proposed 80,000-kw low-pressure machine. The nozzles and blading of No. 5 unit will be of stainless steel, the cylinder of carbon-molybdenum steel and the spindle an alloy-steel forging. Glass-wool blankets will insulate the turbine.

Generator

The generator is rated 50,000 kw, 80% pf, 62,500 kva, 13,800 volt, 3 phase, 60 cycle with hydrogen cooling at approximately 0.5 lb g pressure. Provision has been made for operation with hydrogen pressure at 15 lb g which is expected to increase the generator capacity 15% without injurious heating. The rating of the generator operating with air cooling is 31,250 kva, 80% pf. Excitation will be obtained from a 190-kw, 250-volt, 1800-rpm exciter through a 2-to-1 reduction gear. The pilot exciter, 4 kw, 250 volt, 1800 rpm, is direct connected to the main exciter. Four fin-type coolers will provide for hydrogen cooling in the closed circuit, any one of which may be disconnected for inspection or maintenance without injurious heating of the generator when the latter is operating at rated load.

The over-all dimensions of the unit, including turbine-generator and exciter are: length 54 ft, width 14 ft, height 11 ft.

Boilers and Auxiliaries

Steam requirements and space limitations for the new installation resulted in the selection of two 600,000-lb-per-hr, open-pass, pulverized-fuel-fired, continuous-slag-tap boilers generating steam at 1350 lb and 935 F with feedwater to economizer at 400 F. These steam generators are arranged as shown on the accompanying cross-section, Fig. 5. Water circulation in the tubes is such that all of the tubes discharge upward into one steam drum of 66 in. inside diameter. They are all connected at the bottom either directly or indirectly through headers to a single water drum of 30 in. inside diameter.

Circulation for the tubes is obtained by two 25-in.-inside-diameter external downcomers, one at each end of the steam drum, to the lower drum. All of the steam and water entering the upper drum discharges behind a solid baffle which, in turn, opens into a number of cyclones. This simplified tube and downcomer arrangement insures adequate circulation. The use of cyclone separators with which the steam drum is equipped is expected to insure the very minimum of carryover.

The horizontal-return-bend superheater is so arranged that steam flow is counter to gas flow. Each continuous tube is connected to an inlet header at the top and to an outlet header at the bottom by welding each tube to nipples which in turn are welded into the inlet and outlet boxes at the shop. Total temperature of the superheated steam is 935 F and control will be by means of dampers positioned by the automatic temperature control.

The continuous-tube economizer consists of an upper section and a lower section, the lower section being in the superheater bypass. Water flows downward in the upper section and upward in the lower or bypass section.

Coal Pulverizers

Three coal pulverizers are provided per boiler. Each pulverizer consists of one set of upper and lower grinding rings and one set of balls, with the lower ring as the driven ring. The primary-air fan handles clean air only and is arranged so that the mill is always under pressure. This avoids abrasive action of coal on fans. The unit system is used throughout.

The pulverized-coal burners (six per boiler) are vertical-intertube units. The stream of primary air and pulverized coal from each burner nozzle is dispersed in passing between the tubes of the furnace roof. Secondary air enters the furnace through ports between the primary air nozzles.

The full-load furnace heat release will be 27,800 Btu per cu ft per hr based on an effective furnace volume of 27,000 cu ft. The design incorporates an opening in the furnace bottom for continuous slag tap. The molten slag flows into a water-

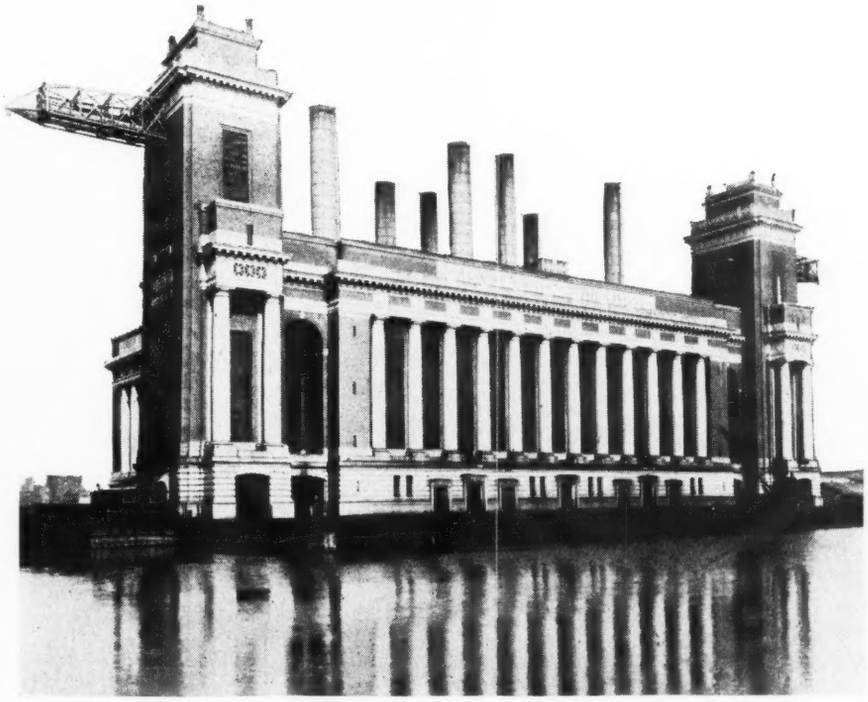


Fig. 2—Chester Station faces the Delaware River at Chester, Pa.

filled pit under the furnace. Dry slag, which accumulates on the hopper bottom under the superheater and economizer pass, is collected in a dry ash pit which extends the full boiler width. Steam floor blowers are provided for moving any ash which may stick to the furnace bottom. A common sluicing system will remove slag from the water-filled pit and the dry ash pit to the outside storage pit. Sluicing water is decanted from this pit.

Boiler Auxiliaries

The boiler auxiliaries include two regenerative counterflow preheaters and two forced- and induced-draft fans per boiler. The forced-draft fans have a rated capacity of 102,500 cfm each when operating at 1125 rpm against 14 in. static pressure. The forced-draft fans are driven by 350-hp motors through hydraulic couplings. The rated capacity of the induced-draft fans is 187,500 cfm each, and they operate at 868 rpm and discharge against a static pressure of 25 in. 1000-hp motors drive these induced-draft fans through hydraulic couplings. A centrifugal collector concentrates the flyash before the gas from the boiler is discharged into the stack. One stack, of 22½-ft diameter, serves both boilers.

Flyash from the centrifugal collector is pneumatically transported to the two dry-storage tanks. The transport system forms part of the flyash-collector equipment. Flyash is then discharged from the dry-storage tanks through two rotary unloaders to railroad cars.

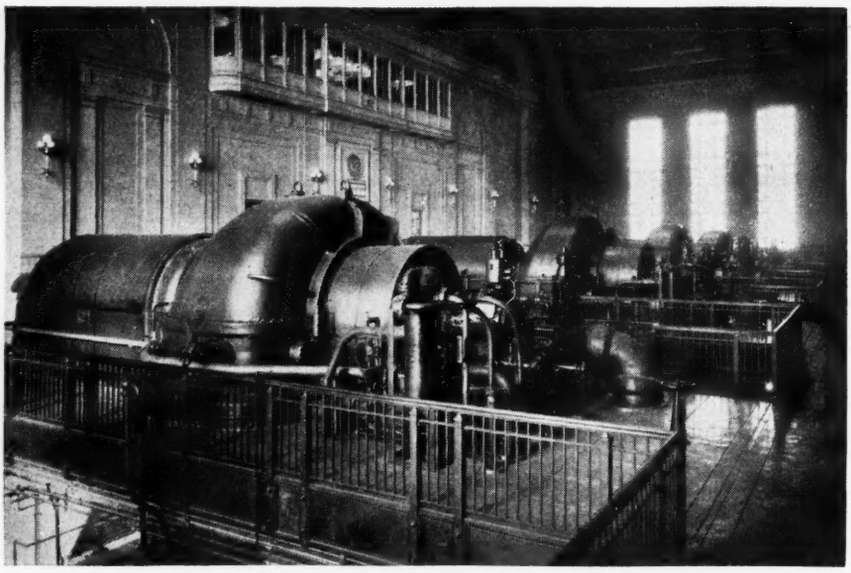


Fig. 3—Four original turbine-generators with total capacity of 126,000 kw

Existing coal-handling facilities were adapted to the new requirements. Building rearrangements were kept at a minimum, with equipment fitted to available space within the existing building.

Heat Balance

The heat balance (see Fig. 6) was designed to provide satisfactory operation of the new equipment in conjunction with a future 80,000-kw, 250-lb, 570-F, condensing unit as well as with the four existing low-pressure units and their associated equipment. When generating 50,000 kw, the topping unit will exhaust sufficient steam to operate three of the four existing turbine-generators at approximately their most efficient load points in addition to supplying the steam necessary for auxiliaries and feedwater heating.

Condensate from the existing low-pressure units is heated to 200 F by four deaerator condensers, an evaporator condenser, and four open heaters. Steam is supplied to the open heaters and evaporators at atmospheric pressure from the auxiliary turbine drives and from an

PRINCIPAL NEW POWER EQUIPMENT

Units No. 5 and 6, Chester Station, Philadelphia Electric Co. (Note: Equipment for Unit No. 6 consist primarily of turbine-generator and auxiliaries given at end of this table)

Steam-Generating Equipment:
Boiler, 2, waterwalls and settings.....Babcock & Wilcox Co
Open-pass, 2-drum boilers; heating surface, each 11,504 sq ft; max continuous steam capacity each, 600,000 lb per hr; working pressure, 1350 lb sq in. g; total steam temperature, 935 F; max furnace liberation, 27,800 Btu per cu ft (continuous performance)
Superheater, horiz continuous tube, 15,800 sq ft.....Babcock & Wilcox Co
Economizer, horiz continuous tube, 17,800 sq ft.....Babcock & Wilcox Co
Air preheaters, four, 2 per boiler.....Air Preheater Corp
29,800 sq ft each Ljungstrom type
Steam washer, cyclone type.....Babcock & Wilcox Co
Structural steel .....Belmont Iron Works
Structural-steel erection work.....Lehigh Structural Steel

Feedwater System:
Boiler-feed pumps, 3, 1700 gpm, 1405 lb.....Ingersoll-Rand Co
Boiler-feed-pump turbines, 3, 2000 hp.....Worthington Pump & Mach Corp
Variable-speed, non-condensing, automatic control on multi-valve inlet
Condensate-storage pumps, 2.....Worthington Pump & Mach Corp
1000 gpm, 125-ft total head, 1750 rpm
Direct-contact heater, 1, 1,008,000 lb per hr.....Westinghouse Elec & Mfg Co
Feed heaters, 2, horiz, 824,000 lb per hr each.....Alco Products Co
Feed heaters, 2 vert, 824,000 lb per hr each.....Alco Products Co
Evaporator, 1, horizontal, 2300 sq ft.....Westinghouse Elec & Mfg Co
Drain cooler, 1, 30,000 lb per hr.....Westinghouse Elec & Mfg Co
Zeolite water softener, 1 double unit.....Cochrane Corp
Capacity 65,000 gal. each between regenerations
Exhaust desuperheater and control.....Republic Flow Meters Corp
Bypass pressure-reducing desuperheater.....Republic Flow Meters Corp

Combustion Equipment:
Automatic combustion and superheat control.....Leeds & Northrup Co
Soot blowers .....Vulcan Soot Blower Corp
Burners, 6 per boiler.....Babcock & Wilcox Co
Vertical intertube, capacity each, 187,000,000 Btu per hr
Pulverizers, 3 per boiler, ball mill.....Babcock & Wilcox Co
Pulverizer and fan driven by same 150-hp motor
Lighting torches, steam-mechanical-atomizing.....Babcock & Wilcox Co
Forced-draft fans, 2 per boiler.....American Blower Corp
102,500 cfm, 1125 rpm, 14 in. sp, driven by 350-hp motor
Induced-draft fans, 2 per boiler.....American Blower Corp
187,500 cfm, 868 rpm, 25 in. sp, driven by 1000-hp motor
Hydraulic couplings between draft fans & drives.....American Blower Corp
Feedwater-level control .....Bailey Meter Co
Ash- and slag-handling system.....Allen-Sherman-Hoff Co
Flyash-unloading system .....United Conveyor Corp
Flyash eliminator .....American Blower Corp.
Centrifugal separator, primary multi-unit separators, secondary concentrators

Generating Equipment:
Turbine, 1, 3600-rpm, 1250-lb, 925-F.....General Electric Co
Exhaust at 250 lb g, max throttle flow 1,312,500 lb per hr
Generator, 1, direct-connected, 62,500-kva.....General Electric Co
0.80-pf, 2-pole, 3-phase, 60-cycle, 13,800-volt, 2615-amp
Generator hydrogen cooler.....General Electric Co
Oil-purification system .....DeLaval Separator Co

Generating Equipment, Unit No. 6:
Turbine, 1, 1800-rpm, 250-lb, 570-F.....Westinghouse Elec & Mfg Co
Single-cylinder unit, exhausting at 1 in. Hg
Generator, 1, 100,000 kva, 80,000 kw.....Westinghouse Elec & Mfg Co
0.80-pf, 13,800-volt, 3-phase, 4-pole, 4180-amp, 60-cycle
Hydrogen cooler.....Westinghouse Elec & Mfg Co
Condenser, single-pass surface type.....Westinghouse Elec & Mfg Co

11th-stage bleed point on each of the turbine-generators. Variations in steam requirements are provided for by dual-drive circulating pumps. The feedwater from the open heaters is deaerated in four flash-type deaerators where the temperatures are dropped to 175 F. The existing boiler-feed pumps take their suction from these deaerators. The new evaporator will be inserted in the low-pressure part of the cycle and will receive steam from the 11th-stage bleed points. The vapor will be discharged to the auxiliary-exhaust header and will be condensed in the open heaters. Raw water will be zeolite-treated ahead of the evaporators.

The eight existing low-pressure boiler-feed pumps will supply feedwater to the new contact-type crossover heater through two cycles of closed heaters. Each closed heater is designed for three-quarter load on the topping unit but can be operated at over capacity in emergency. Each of the dual cycles of closed heaters consists of one second and one third heaters. A cycle is isolated by three motor-operated valves, one before the second heater, one before the contact heater, and one in the contact heater bypass line. This provides reliable condensing capacity for the high-pressure boiler-feed-pump turbine exhaust in the third heaters. Steam for the second heaters will be bled from the 13th stage of two of the existing turbine-generators.

A contact-type heater will be used on the crossover system since the existing low-pressure boiler-feed pumps have enough pressure for this type of heater but do not have the excess pressure which would be required with a closed-type heater and 250-lb steam. The contact heater may be bypassed by a 3-way valve in the heater discharge. A net storage capacity of 750 cu ft is provided in the heater.

Feed Pumps

Three new 2000-hp boiler-feed pumps take the feedwater from the contact heater to the boilers. The pumps are driven by variable-speed turbines supplied with 250-lb crossover steam and exhaust to the third heaters at a variable backpressure ranging from 25 to 75 lb depending on load. Two units are required for operation of the two boilers.

Two bypass pressure-reducing valves and desuperheaters make the entire high-pressure boiler output available to the low-pressure units in the event of high-pressure-turbine outage.

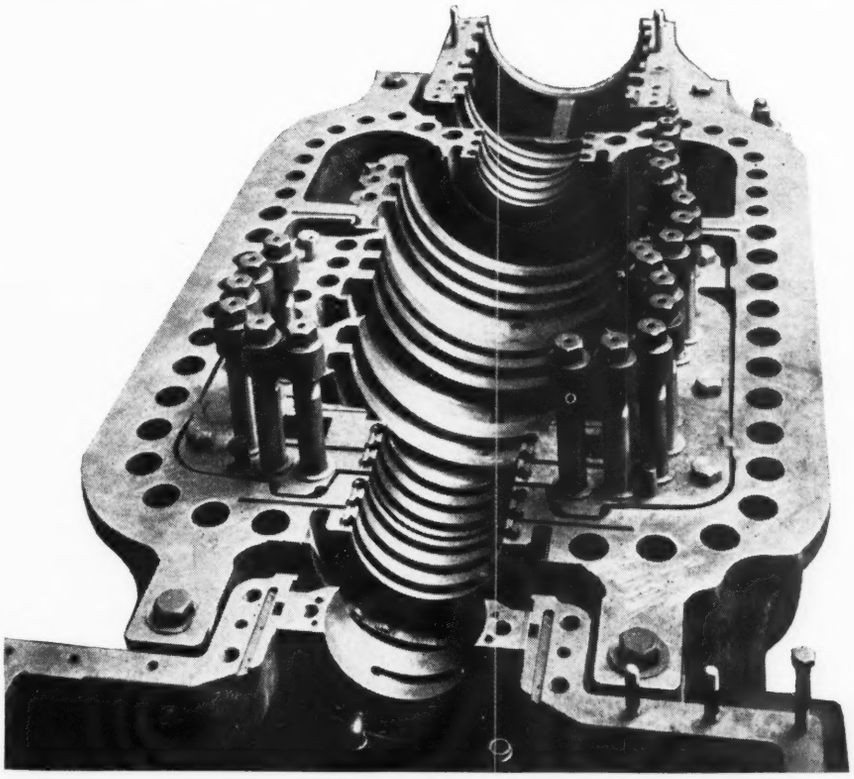


Fig. 4—Double-shell construction of new 50,000-kw high-pressure turbine-generator

The generator connections to the 13.2-kv bus are made up of two 4 x 0.338-in. copper channel sections arranged to form a hollow-square conductor with 1-in. ventilating openings at top and bottom between flanges installed in steel and concrete compartments. A short section of the generator leads is in the basement floor because of interference from the main oil tank. This section is made up of non-leaded 2000-mcm cables, four per phase, installed in transite duct. A 3000-amp, 15-kv oilless circuit breaker with an interrupting rating of 1,000,000 kva and 5%, 1085-kva reactors complete the connections to the main bus. Connection is made to only one of the existing two 13.2-kv main buses inasmuch as later modifications to the station switching facilities are contemplated.

The generator is equipped with percentage differential relays to clear on internal faults and with non-directional impedance relays to clear on bus faults. Reverse-power relays also have been provided which will clear the generator from the bus after time delay of one minute if motorizing occurs. If steam supply to the turbine is interrupted, the turbine will overheat if the unit is permitted to motorize for periods longer than one minute. The reverse-power relays are arranged to give an audible signal instantly on motorizing and to trip the generator circuit breaker if the duration of reverse-power flow is longer than one minute.

The installation of this additional generating capacity has required the rebuilding of the 13.2-kv bus to which the generator is connected. The existing bus of multiple-flat-bar construction was housed in a concrete and alberene-stone structure. Studies indicated that a bus made up of two 5 x 0.26-in. copper channels arranged in hollow-square formation with 1-in. spacing at top and bottom between the flanges installed in the existing structure would furnish the desired capacity at minimum cost.

Power Supply to Auxiliaries

Electrical supply for the boiler auxiliaries is designed to preclude the loss of both boilers in event of electrical disturbances. To accomplish this, the electrical equipment for supply to the auxiliaries of each boiler is contained in a separate room and complete isolation is maintained between cables, transformers, and other equipment involved in the supply. The two auxiliary-power rooms, located one above the other, occupy the space above the boiler-feed pumps adjacent to the boilers. The 2400-volt switchgear, 2400-220-volt transformers, and 220-volt switchgear are contained in these rooms. The voltage characteristics selected for the new equipment are similar to those already existing in the station; 2400-volt, 3-phase—3-wire and 220-volt, 2-phase—5-wire (grounded neutral). In general, motors above 50 hp are supplied at 2400 volts.

Two 13.2-2.3-kv transformer banks, each consisting of two 3000-kva units connected in open delta, are outdoors along the building walls approximately 300 feet apart. Each transformer bank is

equipped with a separate automatically controlled water-spray fire-extinguishing system. These two transformer banks, each of which has sufficient capacity to carry the load of both boilers, will normally each carry the load of one boiler.

Switching Equipment

The 2400-volt switching equipment consists of metalclad switchgear equipped with air circuit breakers. Tie connections are provided between the respective buses for use in case of failure or maintenance operations on transformers or supply circuits.

A grounding device for the 2400-volt switchgear has been developed in conjunction with the manufacturers which is practically foolproof and will greatly reduce the hazard to personnel in blocking-out operations. This device, which is inserted into the switchgear after a circuit breaker is removed, is equipped with motor-operated disconnecting switches which must be operated from a remote-control station outside the room to apply the ground connection to the bus or circuit. The device is equipped with potential transformers and signal equipment to give visible indication of incorrect operation. It is also equipped with interlocking relays which will prevent operation of the ground disconnect switches in event of incorrect operation.

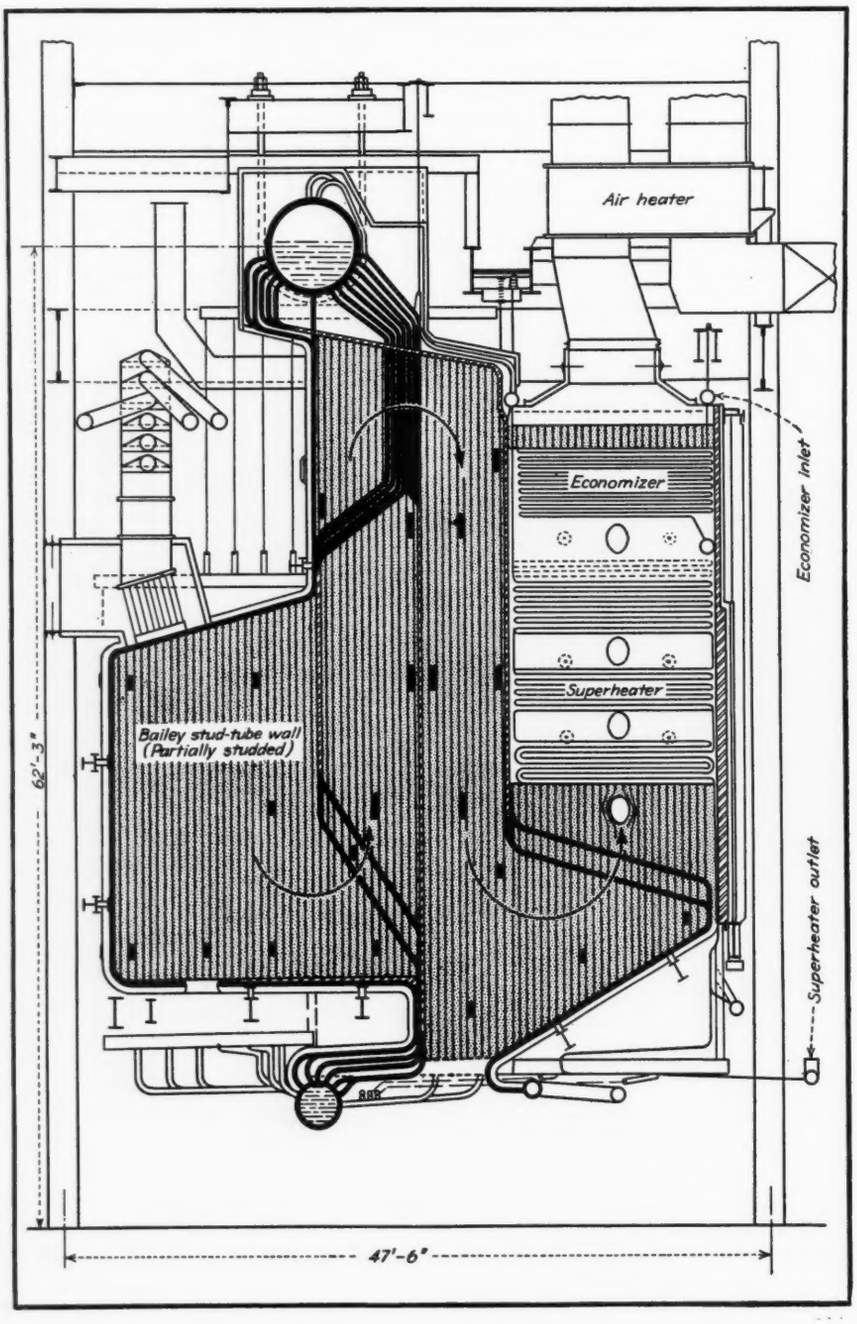


Fig. 5—Cross section of 600,000-lb-per-hr boiler generating steam at 1350 lb, 935 F

Two 400-kva, Scott-connected, 2400-220-volt transformer banks will supply power for low-voltage auxiliaries. Air-cooled transformers with inorganic insulation were selected for the auxiliary-power rooms to eliminate fire hazard. These transformer banks are each of sufficient size to carry the load of both boilers, although normally each will carry the load of only one boiler.

The 220-volt metalclad switching equipment consists of blocking devices and contactors in individual metal compartments assembled into a flush-front switchboard. The 220-volt metalclad switchgear in each room is divided into two sections. One section fed directly from the air-cooled transformer adjacent to it, will supply "non-essential" auxiliaries such as ventilating fans, hoists, ash pumps, and similar equipment. The second section that feeds auxiliaries essential to operation of the boilers is supplied normally from the 220-volt bus in the same room but is automatically thrown over to a supply from the other boiler bus in case of voltage loss of normal supply.

Control Circuits

Armored cable was selected for 220-volt ac and 250-volt dc controls and light power circuits—a deviation from previous practice. This type of cable installed in open expanded-metal troughs produces greater flexibility for construction than the conventional rigid conduit and wire installation and may result in reduction in cost. The use of armored cable did not exclude the rigid conduit entirely, circuits requiring heat-resistant insulation, lighting circuits and circuits that could not conveniently be grouped were installed in rigid conduit. Armored cable used on this project was made to Philadelphia Electric Co specifications with multiple conductors cabled together with a heavy asbestos braid and encased in an interlocking galvanized-steel armor. The size and number of conductors comprising a cable were kept at a minimum and no cables of more than one-size conductor have been used.

For control circuits other than armored-cable circuits, 2400-volt power circuits, and all circuits in wet locations, non-leaded cable has been used with the exception of circuits requiring heat-resistant insulation. For the latter type circuits lead-covered cable has been installed.

The 50,000-kw superposed installation soon to be placed in operation and the forthcoming installation of an additional 80,000-kw, low-pressure unit in Chester Station are further evidence of the Philadelphia Electric Co's desire to serve effectively this metropolitan area's present and future requirements.

CHESTER STATION

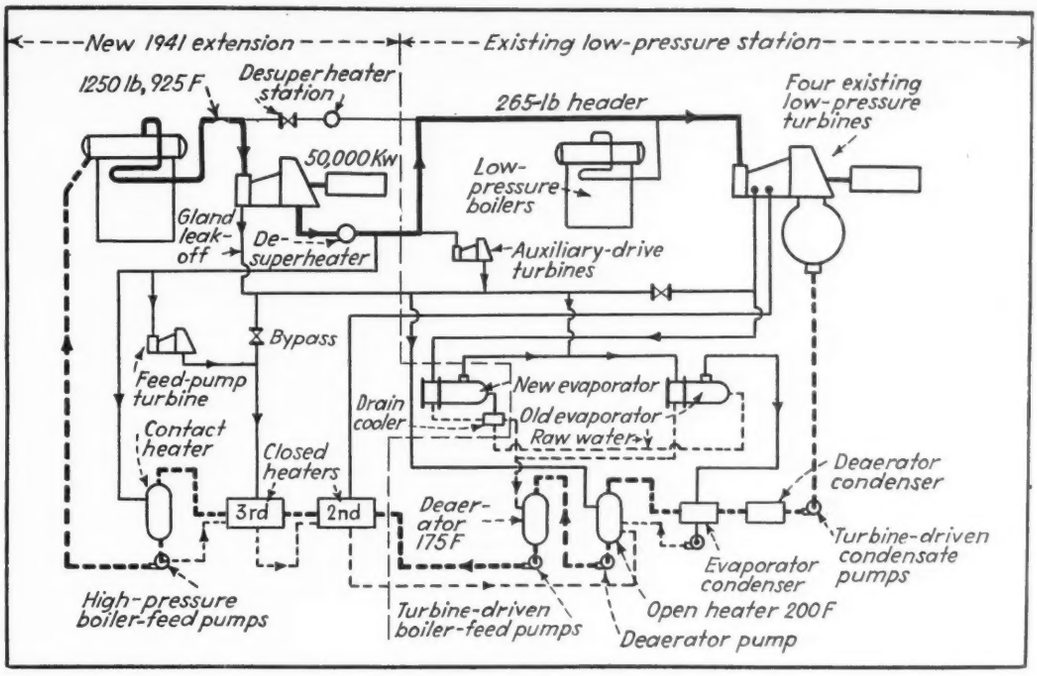


Fig. 6—Schematic heat-balance diagram for 50,000-kw high-pressure extension. Only change in existing part of the station is addition of evaporator

No. 1 Traveling Gantry

► LIFTING the world's largest electric transformers is no unusual or extraordinary task for this special 200-ton traveling gantry crane, which itself holds records for size and capacity.

Similar to others on the system of the Los Angeles Bureau of Power & Light, this crane is used for assembling, inspecting and repairing transformers, including the four world's largest transformers on the receiving end of the Bureau's third 287,000-volt Boulder Dam Transmission Line.

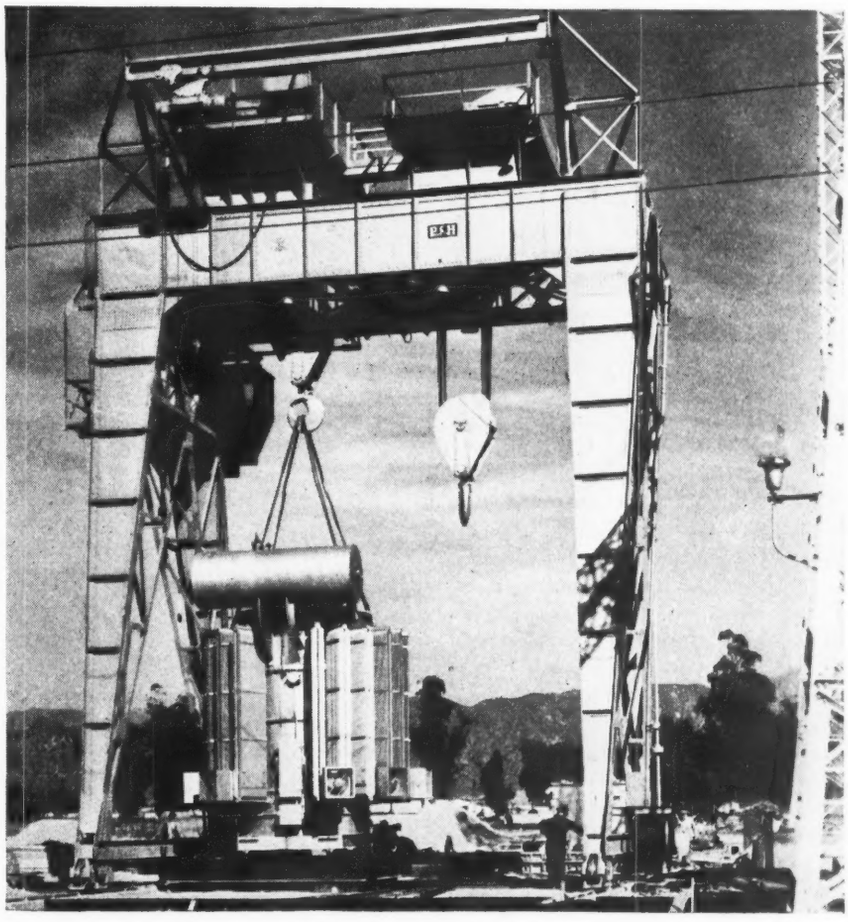
The Transformers It Lifts

These Westinghouse transformers operate in a bank of three (one spare) to step-down 60-cycle Boulder power from 275,000 to 132,000 volts, and have a capacity of 65,000 kva, with a 2-hour overload rating of 80,000 kva. They are oil immersed, forced-air cooled, with 13,200-volt tertiary windings for use with synchronous condensers.

The P & H (Harnischfeger Co) 200-ton crane has two 100-ton main hooks and an auxiliary 2-ton hoist. The main hooks have a maximum and minimum travel speed of eight and six fpm and a vertical lift of 40 feet over the 110-lb rails, set 35 ft apart giving 28 ft between crane legs.

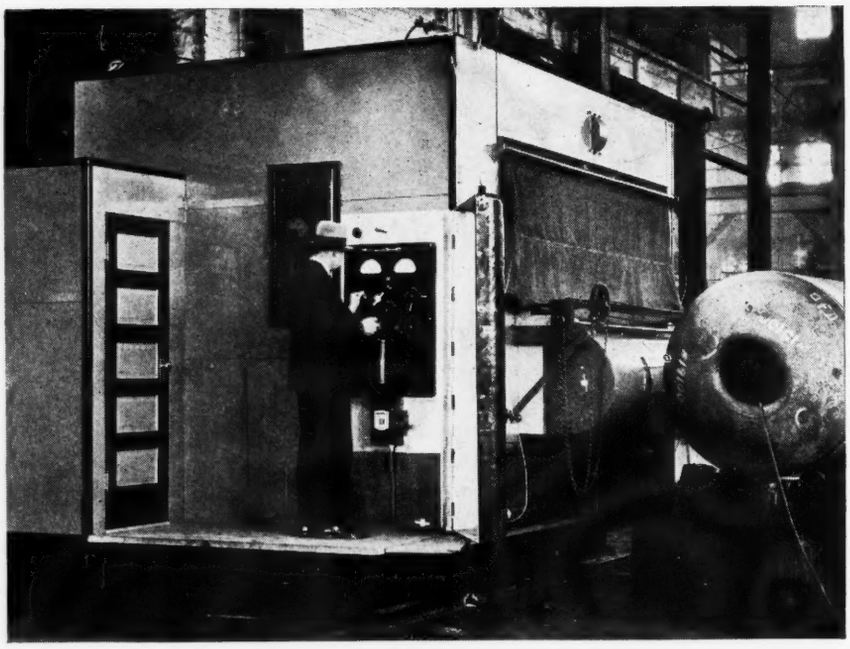
The crane was tested at 125% capacity and one of the specification requirements of Bureau engineers was that each main hoist, when carrying test load, could be maneuvered to 1/32 in. The net weight of the complete crane unit is 219,600 lbs. The transformer being lifted at the time the above photo was taken is one of a bank of three weighing 100 tons each, used to step-down from 132,000 to 34,500 volts.

Carl D Udell and V Lankovsky had charge of mechanical and structural design and R R Robertson, Engineer of Design and Construction, and G E Genkesser, Superintendent of Construction, made the installation.—C M ALLEN.



Building a Boiler

Have you ever wondered what it feels like to be in on the birth of a boiler? Robert H Emrick here records the confessions of the designer—a combination father, doctor and midwife



Doc applies the stethoscope to see how the kid is coming along (X-raying a drum)

▶ BUILDING A BOILER involves two processes—first the planning on paper, and second the doing in steel. To illustrate the gestation and birth pangs of a boiler in the mind and shop of the manufacturer, let's assume that specifications have been received for a unit capable of delivering 60,000 lb of steam per hour, at 400 lb g working pressure and 675 F total temperature. Feedwater will be supplied at 250 F.

When the specification arrives in the Engineering Dept, mental wheels commence to whir. Does this unit, someone asks, look like the best design for the service intended, or should something a little different be offered as an alternate? At this time the need for additional information shows itself. Operating conditions and limitations, such as extra data on space, draft, fuel and the nature of the load are usually required and demanded.

How About the Operator?

Someone is sure to ask if the operating personnel are or will be sufficiently trained to handle the steam-raising humdinger the specifications describe. After all, you will remember, there have been cases when the cause of bad priming in the boiler was found to reside in the person of a missing fireman.

The boiler wanted in this case is a forged-steel, sectional-header beauty, with cross-drum and waterwalls. The boiler designer starts his work by fixing one eye on engineering characteristics required, and the other on costs, and after a few hours of headache, succeeds in laying out a design that looks, for the moment, like the answer to an engineer's prayer.

Now follow the critical studies of the unit's operating characteristics such as draft loss, heat liberation in the furnace, flue-gas temperatures, efficiencies, etc. These data are determined by complex mathematical processes, involving combustion, heat transmission by radiation and convection, weights and volumes of air, ditto for the products of combustion, tube spacing, velocities and how clean will the operators keep the boiler. At this stage of the job it is not enough for the designer to be an expert mathematician, he must be part chemist and part research engineer as well.

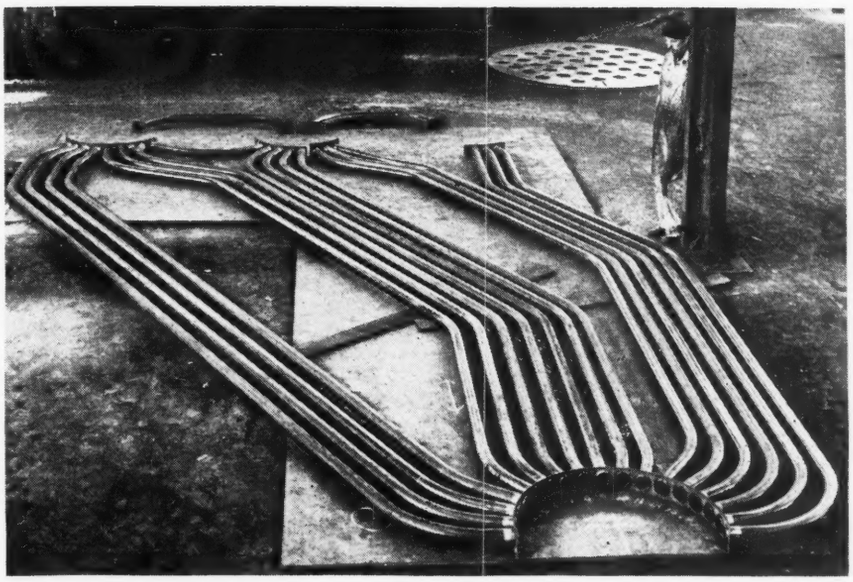
It would be too easy, and not true, if we were to say that the mathematical studies of the boiler we are now considering confirmed the designer's estimate of it as a perfect layout. These studies never do, which is the reason the designer is never happy when making them. They always pour tangible drops of cold water on his beautiful ideas.

In this case, we will assume the heat release in the furnace figures entirely too high. The effect in practice might be refractory failure, unsatisfactory combustion, secondary combustion in the after-passes of the boiler, confused circulation, tube failures, and other complications. The designer now considers raising the setting and finds the boiler-house roof won't hear of such a scheme. Lowering the setting by digging into the floor is ruled out by the danger of water, or by just plain inconvenience in getting at the firing equipment. This leaves but one alternative, and with a sigh of regret, the designer decides that the boiler must be wider. A wider boiler means more headers, more brickwork, and a longer drum, all of which add to the cost of construction. At this point the designer usually goes home, kicks the cat and refuses to speak to his wife.

Plans at Last

However, even trouble comes to an end in time, and after going to work on his new and wider boiler, the designer now finds, praise be to Allah, that the draft loss, efficiency, space occupied, superheater location, and all other features from a physical and operating standpoint, when added together, comprise a very nice-looking boiler and one which will perform in the manner desired.

There may be a little more heating surface than the minimum specified, but, as the designer points out, minima are always too much that way, and



Pattern for the new generator—bent-tube-boiler template

the purchaser will come to appreciate the few extra square feet available.

"What makes the boiler groan so loud?" said the Big Boss at her side.
"She's steaming more than she's surfaced for," the engineer replied.

"Now *there* is a situation," says the designer proudly, "in which you will never find *this* boiler."

So the details are now worked out, the drawing made, the selling price determined by expert estimators, and in due course the complete proposition is ready for presentation. However, the designer is not finished in this case because we will assume the manufacturer is offering an alternate boiler, which means he must suffer his headaches all over again.

For the alternate, it is planned to offer a 4-drum, bent-tube unit, which is a little more difficult to work out than was the straight-tube job. The reason for this is that the heating surface per section of the sectional-header boiler is well standardized with each manufacturer, and variations in the total surface are readily obtained by varying the number of sections, by increasing or decreasing the number of tubes per section, by changing the length of tubes, and not infrequently, by a dexterous juggling of all three elements.

This looks complicated, but actually it is less tedious to arrive at a total heating surface this way, than to work with the bends and different tube sizes encountered in a bent-tube boiler. Templates must be drawn and tube lengths measured carefully and always a finished template is either too big or too little and must be redrawn. It is a tedious, time-consuming process, and the final template which meets space and surface requirements, is no less vulnerable to the criticisms of draft loss, efficiencies, cost of building and such factors. Nevertheless, the designer attacks the problem bravely, and in due course solves it.

At this point, the first phase of building a boiler, namely the gestation in the mind of the builder, is complete. Also in many cases, because everybody won't get the order, it is the signal for a still birth. However, we are going to assume that our designer and Sales Dept have done so good a job in presenting their alternate designs, that the purchaser straightway orders one of each. This probably never happens, but it's going to happen this time to give us a chance to watch two distinct designs going through the shops.

Life Begins

The drums begin life as two simple steel sheets of the thickness and tensile strength needed to meet the pressure requirement. These sheets are sheared to size and given to the bending rolls, where they assume a cylindrical, open-ended shape of the proper diameter. In late years, the longitudinal seam is usually closed by welding and if you will look at the first photo you will see the X-ray machine which radiographs each and every inch of the weld.

If the specifications call for a riveted boiler, the job is done by slipping the drum over a riveter, then rotating it or moving it up and down as required, while the rivets are driven home.

And now for the forged-steel serpentine headers. A length of seamless steel tubing is selected, suitable for the pressures and temperatures expected, and this tubing is given to the forging furnace for heating to the desired temperature. To secure the best results, it is necessary to complete the forging of the header at a temperature well above the critical, otherwise molecular changes take place in the metal which result in granular structure and inferior strength.

After the header comes from the forging hammer and mandrels, the ends are closed. Hand-hole openings are then roughed out, to be finished a little later on the milling machine. Both roughing out and milling are done with fixed settings of the respective machines, so that the final product of these processes is mathematically exact. Hand-hole plates are one-piece drop-forged with the stem and plate integral, and machined to fit. Tube holes are drilled and reamed at the precise angle required by the slope of the tubes.

The tubes and headers comprising each section are usually shop assembled and tested before shipment, which makes for rapid and comparatively easy erection in the field. Water-wall headers are forged similarly, except that the serpentine feature is necessarily omitted.

Birth of a Bent Tube

The shopwork on a bent-tube boiler is less involved. The keynote is accuracy of drilling and accuracy of tube bending. Most bent-tube boilers, unless they are very small low-head units, must be assembled in the field, and if tubes and drums do not fit as they should, the whole job is delayed, confused, and unexpectedly expensive.

To avoid such undesirable situations, a full-size template is made of the boiler section, and each tube, when bent and cut, is fitted to the template, before shipment. All bent-tube boilers are built essentially in this manner, that is, the drums are rolled, closed, drilled and X-rayed, and the tubes are bent to full-size templates.

Frequently, boiler manufacturers are called on to supply the baffles going into their units, and a brief statement regarding the locating of these baffles will be of interest to operating engineers who may wish to change or replace these items. Gas passes are sized to provide the greatest possible efficiency of heat transfer with the minimum draft loss. A basic approach is to allow a large initial gas-pass area which is gradually reduced until approximately 75% of the boiler heating surface has been passed, the area remaining generally constant thereafter.

The author wishes to acknowledge the assistance of Messrs L R Jackson, boiler designer, and G W Plincke, welding supervisor, of the Henry Vogt Machine Co, Louisville, Ky.

Fig. 1—Control room of Safe Harbor plant showing bench and instrument board for six main and two service units

Safe-Harbor Hydro Plant Meters Water Flow—II

Second of two articles shows how an extremely accurate metering system has been applied, gives the results obtained and describes a signal system that indicates the most efficient loading of hydroelectric units in the station

By J M MOUSSON
Hydraulic Engineer, Safe Harbor Water Power Corp

▶ DURING 1936 AND 1937, the Safe Harbor Water Power Corp made various studies on remote unit-discharge totalizing equipment and on the possibility of using it as part of unit and station efficiency indicating and recording apparatus. By 1938, plans had crystallized to where we felt safe to proceed with the installation of flowmeter equipment for all units, as well as the flow-totalizing apparatus for the entire station.

The flowmeters selected were installed in cabinets originally provided on the generator-room floor, adjacent to and forming an integral part of the gage boards of each unit, Fig. 2. This installation included eight flowmeters, one for each of six main units and two service units. On all units the flowmeters were connected to the Winter-Kennedy piezometer pair R_1–R_2 (see first article published in October POWER) and calibrated according to data obtained during tests on the units. It should be noted that the error characteristics of these meters had been so improved that no correction of any sort had to be applied over the entire range of turbine discharge actually used. Another desirable advantage of these meters is that the checking or recalibration is very much simplified by calibrated weights, hung on one arm of the tilting mercury manometer, thus eliminating the use of standard water columns.

Power supply for the flowmeter-motor integrators is obtained from the 120-volt, 60-cycle station-service system at outlets on each unit gage board. The totalizing apparatus was installed on a panel of the relay board in the control room. Its principal parts consist of four impulse totalizing relays. Three of these (*A*, *B* and *C*, Fig. 3) serve as unit discharge totalizers, each for a group of three turbines. The fourth relay (D) serves as master totalizer for the entire station and records the sum total of three unit-totalizing relays. A spare position on totalizing relay *A* will be

used for the flowmeter at No. 1 unit, now being installed.

While the input-output ratio of the unit totalizing relays is 5: 3, the master totalizer has a ratio of 3: 1. Since each impulse sent out by the interrupter on the counter shaft of the individual flowmeters represents 20,000 cu ft, each impulse received by the station total-discharge counter from the master totalizing relay corresponds to 100,000 cu ft. Individual unit discharges can be read on the individual impulse counters of the unit totalizing relays. Mechanical counters were provided on all flowmeters to facilitate checking of impulse transmission and relay operation, as well as for rechecking the calibration of the flowmeters themselves.

A total station discharge graphic recorder and discharge indicator, combined in one instrument, Fig. 5, was installed on the instrument panel opposite the totalizing-relay panel. The upper range limit of the graphic recorder and the indicator was chosen as 80,000 cfs, representing the approximate maximum station draft for a number of years in the future.

Flowmeter Data

During 1939 various investigations were made based on data obtained by the flowmeters. The operators were required to read the individual-unit discharges and the station total draft every hour on the hour, together with the unit and station integrating watt-hour meters, and the forebay and tailwater levels. Operators were still charged with computing the individual unit and total station drafts based on power output, as had been standard practice. We felt that a long term comparison was essential to obtain the proper basis for continuous-flow records, the transition period furnishing the ratio between computed and automatically recorded station drafts under the various seasonal loading schedules. Once sufficient data has been accumulated, it is expected that the operators will be relieved altogether from computing the discharge based on output.

Data obtained by the operators were also used to investigate unit and station-operating efficiencies. An investigation of this kind was all the more essential, as during approximately 290 days of the year the available river flow is less than the station draft required with all six main and two service units operating at maximum capacity. After the 7th main unit (now under construction) goes into service, the corresponding period will increase to 305 days.

It is interesting that an input yardstick had a decidedly stimulating effect on the operating personnel. During the first month of flowmeter operation, January, 1939, the actual loss in generation exceeded the expected loss on 23 days. The following May, under similar river-flow conditions and loading schedules, actual losses exceeded expected on only 13 days. It has been estimated that an improvement in operation of this magnitude will increase station output at least 0.3%, or approximately 1,700,000 kwhr per year with the present installation of six main units and about 1,900,000 kwhr with the 7th main unit in service. Thus, the flowmeter installation will pay for itself in a very short time, particularly as substantial further improvements in operation are yet to be achieved.

With a close continuous check on unit operating efficiencies available, it was also possible to keep the losses due to trash on the intake racks appreciably below those which must have prevailed in previous years. Prior to installation of the flowmeters, the rack losses were determined from time to time by measuring rack-head loss. Now, as soon as a unit shows a drop in operating efficiency, as indicated by hourly readings, the rack losses are determined independently. After cleaning the racks, operating efficiency invariably increases to the expected level. Although it is difficult to estimate the increase in station output due to obtaining an earlier indication of this loss in efficiency, we believe the gain is substantial.

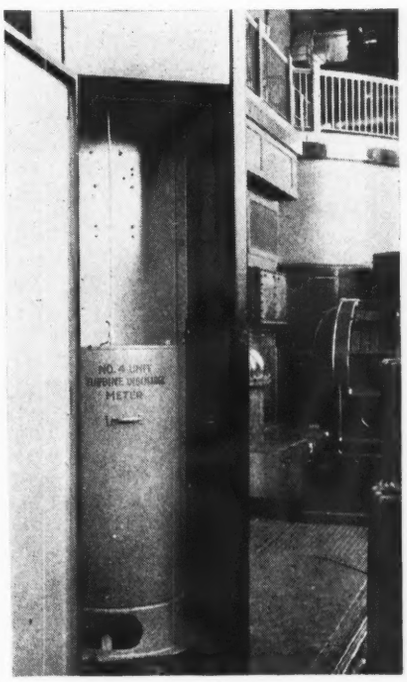
Since the flowmeters permitted short-duration turbine-efficiency tests to be made by one man, it has been possible to investigate the efficiency of each main turbine over the whole range of operating heads. This procedure was desirable because these Kaplan turbines require an adjustment of the cam controlling the gate-blade relation for the various operating heads. The operators have been required to change to a new cam setting after every foot of change in head.

While these compensating devices on all main units were originally designed and calibrated on a minimum of information obtained by costly testing procedures, the flowmeters made it possible to check and recalibrate them with a large amount of information obtained with a minimum of effort.

Although five of the six main units were of identical design, their characteristics were found to be sufficiently different to warrant individual cams, and individual calibration of the cam-adjustment device for head variation. The results of this investigation reflected favorably upon the operating efficiencies of the individual units and the station as a whole.

Checking Efficiency

As a next step, a detailed study was undertaken to determine the magnitude and duration of avoidable inefficient operation in per cent of total operating time. Fig. 4 shows the ideal loading schedule for the main units, valid for a gross head of 55 ft. It is apparent that



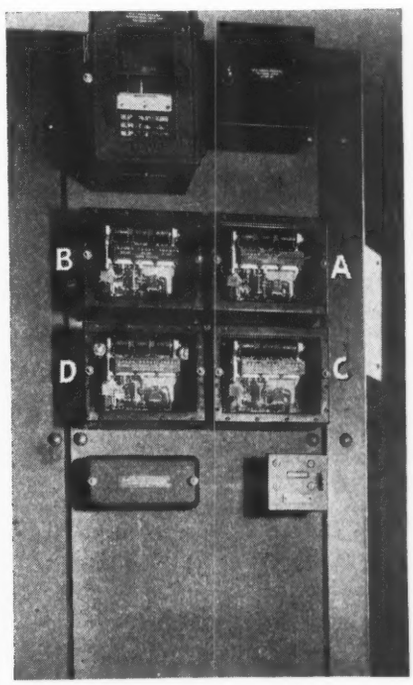


Fig. 2 (left)—Flowmeter installed in cabinet on generator-room floor forms part of the gage board at each unit. Fig. 3 (right)—Totalizing relays and station total-discharge counters installed on relay board in control room

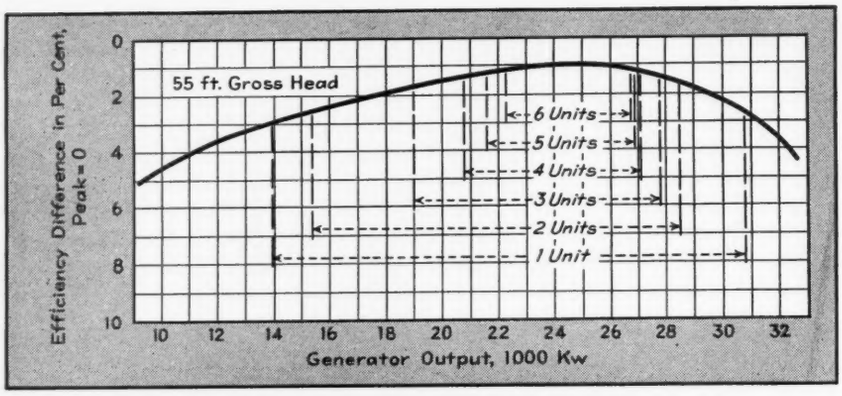


Fig. 4—Typical loading schedule for Safe-Harbor main units

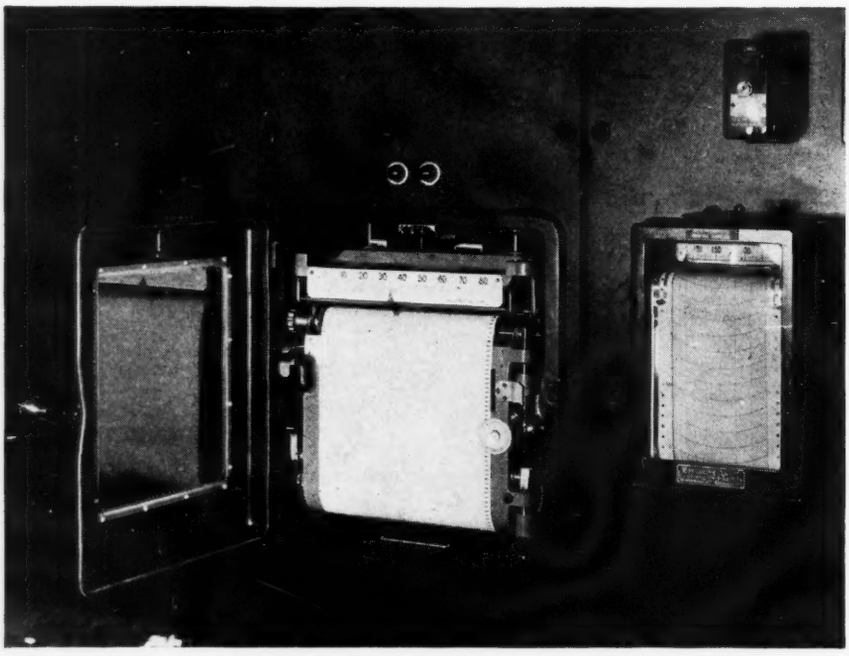


Fig. 5—Station total-discharge indicator and recorder installed in control room

the band of permissible load variations of each unit decreases with increasing number of units on the line. When the required capacity is above the most efficient station-operating range with all available units operating, all individual unit loadings are increased by equal amounts up to the point of maximum capacity.

By analyzing the total station-discharge recorder chart in the light of the operator's log, we found that considerable periods elapsed between the time of placing units on or off the line and the ideal loading schedule. These losses, though not excessive compared with some other stations, amounted to about 10% of the total operating time on the average. This offered considerable room for improvement, provided instantaneous warning could be given when load should be reapportioned to individual units. Some thought was again given to efficiency-indicating and recording apparatus, but another simpler and less expensive solution was discovered.

Characteristics of our Kaplan-type turbines are such that their most efficient discharge range is independent of the head if the loading schedules for each head, Fig. 4, are adhered to. Thus, the discharge with one unit operating within the permissible load range varies between 4000 and 8200 cfs, irrespective of the head. The discharge ranges with any given number of units operating are also constant, that is, independent of the head for all practical purposes. These characteristics, plus taking proper account of station-service-unit draft requirements, permitted us to provide for an automatic and instantaneous load-limit-indicating apparatus as part of the total-station discharge indicator and recorder, Fig. 5.

Essentially, this device consists of a contact-making cam arrangement lighting up two warning lights, one on the operator's desk and the other on the instrument board. For each load or discharge limit, there is available one contact-making cam. All contacts are connected in parallel and independently adjustable as to what point of the discharge scale they will operate. While for No. 1 discharge limit an actual contact making hand has been chosen, it is a definite point for all other discharge limits as given in the table.

DISCHARGE LIMIT SETTING FOR LOAD LIMIT LIGHTS

No. of discharge limit	*Discharge Limit Setting cfs*	*No. of main units to be operated below limit*
1	0-4,000	0
2	8,200	1
3	14,900	2
4	21,400	3
5	27,500	4
6	33,900	5
7	40,800	6
8	48,000	7

Eight discharge limits were provided because the 7th main unit is now being installed. An indication is also needed when the station, with all 7 main units operating, reaches the upper limit of the most efficient operating range. The warning lamps will remain lit as long as inefficient operation exists.

Load-Operating Range Scale

The scope of the station total-discharge indicator and recording instrument will be increased by adding a load-operating range scale. Each division of this scale corresponds to the permissible range of discharge for a certain number of units in operation, as shown in the table. By this improvement, it will be possible to see at a glance how many units should be in operation at any time. When reaching a load limit, as indicated by the warning lights and by observing the shape of the discharge curve plotted by the station-discharge recorder, it also will be apparent immediately whether a unit should be put on or taken off the system.

The installation of this load-limit-light apparatus is now in progress and its use is expected to reduce avoidable inefficient operation to a negligible amount, resulting in an additional and substantial increase in operating efficiency and station output.

For those interested in further study of water-measurement problems in hydroelectric plants the following articles are recommended:

"Improved Type of Flow Meter", by Ireal A Winter, *Proceedings ASCE*, Vol 59, No. 4 Part I, April 1933, pp 565-584

"Two Methods of Measuring Water to Hydraulic Turbines", POWER, Vol 77, March 1933, pp 126-127

"Water Gaging for Low-Head Units of High Capacity", by J M Mousson, *Trans ASME*, Vol 57, No. 6, August 1935, pp 303-316

"Piezometer Investigation", by C M Allen and L J Hooper, *Trans ASME*, Vol 54, No. 9, May 15, 1932, pp 1-11.

"How We Raise Hydro Efficiencies", by E B Strowger, *Electrical World*, Vol 103, April 14, pp 535-538.

"Waterwheel Testing and Operating Records of Plant Discharge", *NELA Proceedings*, Vol 83, 1928, pp 872-904.

THE OLD CHIEF

I—The "Hot Drops" Cure

First in a series of reminiscences by William Doran, chief engineer, Essex County Sanatorium, Windsor, Ontario. Writing of the inspiration of the past, he has captured much of the human side of engineering that lies beneath the maze of power-plant costs and the waving lines on paper disks

▶ MANY OF THE MEN who have reached the top or near the top of their calling can look back over the years to some genial old chief who encouraged them in their studies and who, from the vast store of his experience, guided their hands and brains along the established practices and landmarks of sound engineering knowledge.

It was my privilege during my twenties to be employed as an operating engineer under the charge of a man whom we shall call the "Old Chief" in a plant like so many in those days—under-boilered, under-staffed, with the latest and best comptometers, adding machines and addressographs in the front office and practically no measuring instruments in the power house.

The War on Blowholes

The engine room was spotless, but in the boiler room we worked 84 hours each week in an atmosphere of coal dust and flyash. We wrestled with big leather belts, patched up foundering shaker grates. We were by turn blacksmiths, machinists and sheet-metal workers. We waged an eternal battle with the blowholes in the fires. The coal we used was mine-run and was selected for us on a pure price basis by the front office. Today this same plant is a model of cleanliness and efficiency and all the credit for the change is due to the Old Chief and his propensity for gathering documentary evidence of the savings that would accrue by modernizing the plant.

For many years I had the pleasure of partaking of my daily lunch in the company of the Old Chief, and so, I grew to know him very well. He was, at the time I first met him, shortish, baldish and fiftyish, blessed with a keen sense of humor and a wealth of interesting stories of men and their machines. He had sailed five of the seven seas as a marine engineer and had grown mellow and wise with the years.

The Old Chief had one weakness, which might be described as a sportive one. I have known him to take an unholy joy in steering and maneuvering unsuspecting white-collar men under the various hot drops that were standard equipment in all plants in those days. If he could register two direct hits down the neck of a victim, he was happy for the rest of the day. I recall a youthful salesman petitioning him to try a coal.

"We guarantee 14,500 Btu's to the 'ton' ", said the salesman airing his inexperience.

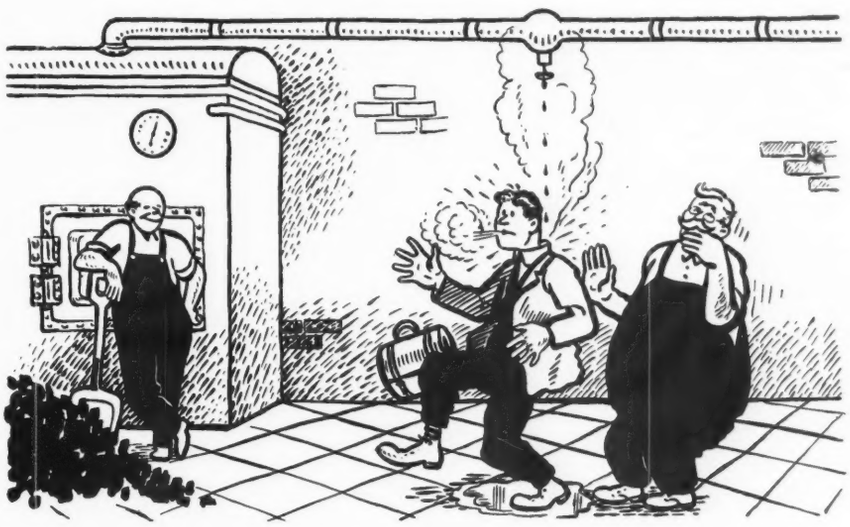
The Old Chief smiled. "How about carbon?" he asked.

"You won't find an ounce in a carload", replied the youth, and he was immediately taken for a round of the hot drops.

I have always a feeling of nostalgia when I remember the engine room as I first knew it. The flooring was 4-in. wood block and wagon-wheel red was the predominant color. The huge flywheel was painted blue with red striping, the guard rail was gleaming brass, the cylinder covering (or cleating as we called it) was hardwood strips, French polished and bound with solid brass hoops 1 in. thick.

Yesterday's Color

Today all is aluminum paint, which I admit is of quality we did not know of in the old days, but I still sigh for the red, blues and greens of the old engine room. I still have in my possession the last indicator cards taken from the big engine and they would gladden the heart of Corliss himself if he could see them. But at last came the day when the tempo of the world increased and higher speeds and temperatures became the order of the day.



A little power-plant experience for unsuspecting white-collar men

Our pride and joy was sold down the river. A big gaping hole was knocked in the engine-room wall and the engine moved out. In the process one of the brass-bound sight-feed lubricators was knocked off. I saw the Old Chief go forward and reverently lift it and place it in his pocket. Later on, he fashioned it into an inkwell for his desk. I believe that having a memento of the old days beside him helped to steady and reassure him in the hectic transition days that followed.

Construction and Operation of Fluorescent Lamps

Dean M Warren, General Electric Co, explains power factor, stroboscopic effect, flicker, radio interference and answers other questions of the day on fluorescent lighting units

▶FLUORESCENT LAMPS, although comparatively new, are coming into wide use. Naturally, many questions about these new lamps are being asked and it is the purpose of this article to answer them.

Certain chemicals fluoresce and give off light when exposed to ultraviolet radiation of the proper wave length—this is the basic principle used in fluorescent lamps. These units are about twice as efficient as tungsten lamps, are available in 18-, 24-, 36-, 48- and 60-in. lengths, in diameters of 1, 1½ and 2⅛ in., and are coated on the inside with a fluorescent powder. Within the lamp tube are two electrodes, one at each end, a small drop of mercury and a small amount of argon gas to facilitate starting.

Fluorescent lamps, as do all electric discharge sources, must have auxiliary control equipment. This consists of an iron-core choke coil and a starting switch *A*, Fig. 1. The choke coil is connected in series with one power lead to the lamp and limits the arc current between the electrodes. The starting switch is in series between the two electrodes and is closed momentarily to heat them and is then opened to start the lamp.

Starting switches are generally automatic. One of the most popular designs consists of a thermal-glow switch and a radio interference condenser in a small cylindrical aluminum container, shown in Figs. 2 and 3. This assembly is called a starter and is placed in a socket at one of the lamp terminals. The two terminals on the starter connect to the lamp terminals, as does the switch in Fig. 1. When the lamp is connected to the power circuit, voltage at the starter is sufficient to produce a glow discharge between the bimetal strip and electrode. Heating of the bimetallic strip causes it to contact the electrode heating circuit. Because the glow discharge is now short-circuited out, the bimetal strip cools, soon opens the starting contact, and the inductive kick from the inductance starts the lamp, after which the arc is sustained by the mercury vapor produced in the tube. Voltage at the starter is now not sufficient to cause a glow discharge and the starter remains open.

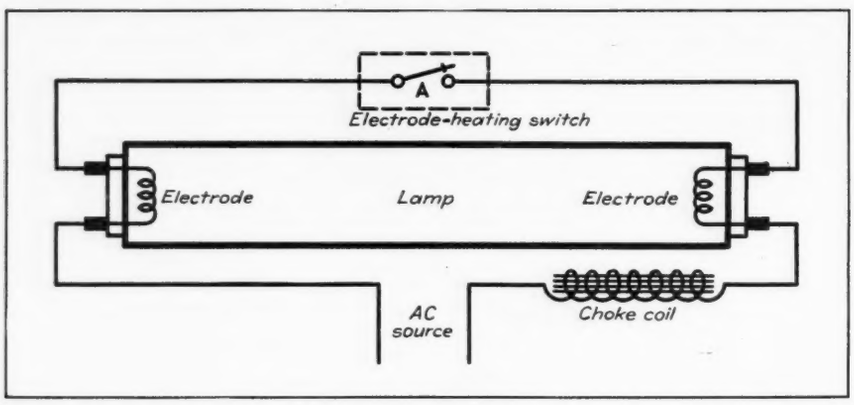


Fig. 1—Diagram of a fluorescent lamp and its starting circuit

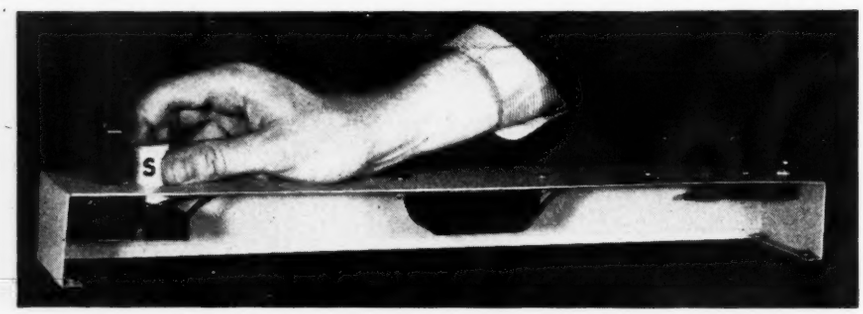


Fig. 2—The starter *S* element most likely to cause trouble but it's easily replaced

The mercury arc within the tube, rich in ultraviolet light of the proper wave length, activates the fluorescent material with which the inner surface of the tube is coated and produces visible light. The color of the light depends on the chemical composition of the fluorescent material. By the proper blending of the phosphors, as they are called, a wide range of colors can be produced. Today's color range includes daylight, white, bluish-white, blue, green, gold, red and pink. The first three are used for utility lighting, but in some cases daylight and blue lamps are combined to give the desired color quality.

"Ballast" for PF

A fluorescent lamp's inductance, or ballast as it is called, is simply a coil of wire wound on an iron core. Because of this inductance the lamp assembly would have a comparatively low power factor. To correct the power factor, ballasts combine a capacitor (static condenser) with the inductance. This equipment is available for operating either a single lamp or two lamps at high power factor.

The high-power-factor single-lamp ballast contains a shunt capacitor that raises the over-all power factor of the lighting unit to 90% lagging or better at rated volts. A 2-lamp ballast uses the split-phase principle with one lamp

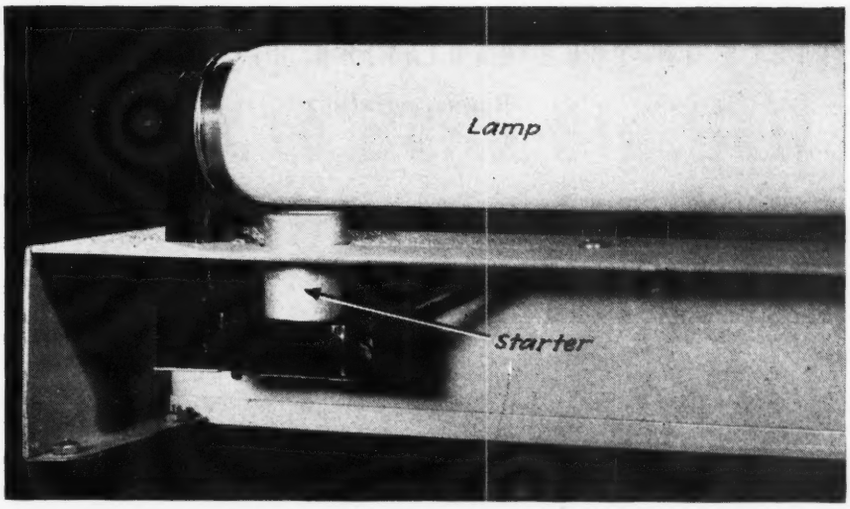


Fig. 3—When starter is in place there is ample clearance between it and the lamp

ballasted by inductive reactance only and the other by inductance and capacitance in series. This results in an overall power factor of 95% or better. At the same time, stroboscopic effect of the lamps is reduced because of the phase displacement in the two branches of the circuit. Two-lamp ballasts for 30- and 40-watt lamps consist of an auto-transformer winding and two reactor windings on a single core, placed in a small container along with its capacitor.

To correct the low power factor of some existing installations and single-lamp units, compact capacitors are available for supplying the necessary leading current. Thus, with a complete line of high-power-factor ballasts plus capacitors for individual or group improvement of older installations, there is no reason for not having a high power factor in all fluorescent-lamp installations.

Frequency and Flicker

Every lamp, when burned in the usual manner on alternating current, has a non-uniform light output caused by the cyclic variations in current. In electric-discharge lamps where practically no energy is stored, the case in the hot tungsten of filament lamps, the light drops almost to zero along with the current between each half cycle. Fluorescent powder, except for the blue, has a phosphorescent action which helps to reduce flicker. With lamps burned on two or more phases or with a 2-lamp transformer, the lamps operate out of phase and the fluctuation in light output is further reduced and becomes comparable to the variation in low-wattage filament lamps. Table I shows the approximate percent deviation from mean light output for different types of fluorescent and tungsten-filament lamps, due to flicker on 60-cycle circuits. This deviation varies from as much as 90% for blue fluorescent lamps to as little as 5% for 100-watt tungsten-filament lamps.

Fig. 4—This installation of 40-watt fluorescent lamps and reflectors in continuous rows provides 45 footcandles of cool well-diffused illumination

Fluorescent lamps are designed to give best all-around performance within the specified voltage range. Wherever possible, they should be operated within the limits of circuit voltages stamped on the auxiliary. Since line voltage is a factor in starting reliability, it should be remembered that voltages lower than those specified may result in unsatisfactory starting.

Lamps operate at their highest efficiency at normal room temperatures of 70 to 80 F. Starting may be unsatisfactory at low temperatures unless conditions favorable to low-temperature starting are selected. The adverse effect of low surrounding air temperature can be offset by enclosing the lamps.

In general, fluorescent lamps lose their usefulness because of decrease in light output before they actually fail. Darkening of the tube occurs due to effect of mercury on the fluorescent coating and because of the material given off by the electrodes. The latter especially causes darkening at the ends of the tube late in life. The rate of depreciation in light output lessens as the lamp gets older. The first 100 hours produce about as much blackening as the following 1000 hours. For this reason the rated output is based on conditions at 100 hours.

Turning the lamp on and off frequently may shorten its life because momentarily there is a higher than normal voltage drop at the electrodes which causes the active material to sputter or evaporate. When the active material on the electrodes is nearly exhausted, the voltage required for starting increases and may equal or exceed the available supply. This may occur after the lamp has been started thousands of times or burned beyond the 2500-hr rated life. Sometimes the end of life is indicated by the lamp flashing momentarily and then going out.

The statement is frequently made that fluorescent lamps produce cooler footcandles than do filament lamps. Some confusion exists as to just how that is possible. Actually, the lamps radiate only about 35 to 40% of their energy as compared to 75 to 85% for filament lamps or about one-half as much, and they are about twice as efficient, Hence the basis for the statement that the sensation of heat from fluorescent lamps is only about one-fourth that of tungsten-filament lamps having equal footcandles.

The mercury arc of a fluorescent lamp

causes a sputtering action on the lamp electrode and a continuous series of radio waves are thus produced. These waves may reach the radio in one or all of the following ways: (1) Direct radiation from the tube to the radio aerial circuit, (2) line radiation from the electric supply line to the antenna, and (3) line feedback from the lamp through the service line to the radio.

In the case of tube radiation, this can be controlled by moving the radio out of range. Table II shows the comparative amount of tube radiation for various sizes of fluorescent lamps.

If it is not feasible to move the radio, then connect the aerial to the radio by a shielded lead-in with the shield grounded or install a double-type aerial with twisted pair leads. Provide a good ground for the radio and place the aerial proper out of tube and line-radiation range. For the type of radio with built-in aerial, adjustment in direction will sometimes provide sufficient station strength for good reception. If this isn't satisfactory then an outside aerial should be provided. Most radios with built-in aerials are also equipped with separate aerial and ground connections so that an outside aerial can be hooked up.

The field of radio energy surrounding the power service lines is termed line radiation. In the case of fluorescent lamps, the field of interference around the lines corresponds to that of tube radiation; consequently, if the aerial circuit is properly protected against tube radiation, line radiation will be eliminated.

The radio energy transmitted from the lamp through the power service line is known as line feedback. The condenser, which is included with each ballast, will practically eliminate line noise produced by the 15- and 20-watt lamps, but the 30- and 40-watt sizes generally require additional filtering. The best method of elimination is through the proper application of line filters at each lamp. Filters suppress the radio energy and bypass it to the ground. The simplest form of filter is the 3-section capacitor. Best results are obtained by using one per fixture.

Table I—Flicker of Lamps on 60-Cycle Circuits

Type of lamp	*Approx % deviation from mean light output*
Daylight	55
White	35
Daylight (2-lamp auxiliary)	25
White (2-lamp auxiliary)	16
Blue	90
Gold	25
Green	20
Pink	20
Red	10
40-watt filament lamp	13
100-watt filament lamp	5

TABLE II—TUBE RADIATION OF RADIO WAVES

Relative Values

Lamp	*Aerial 2 ft from lamp*	*Aerial 4 ft from lamp*	*Aerial 6 ft from lamp*	*Aerial 8 ft from lamp*	*Aerial 10 ft from lamp*
40-watt, 48-in.	100	47	9	4	0
30-watt, 36 in.	90	43	8	1	0
20-watt, 24 in.	75	35	7	0	0
15-watt, 18 in.	55	26	5	0	0

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Single-Stage Pump Develops 650-Ft Head

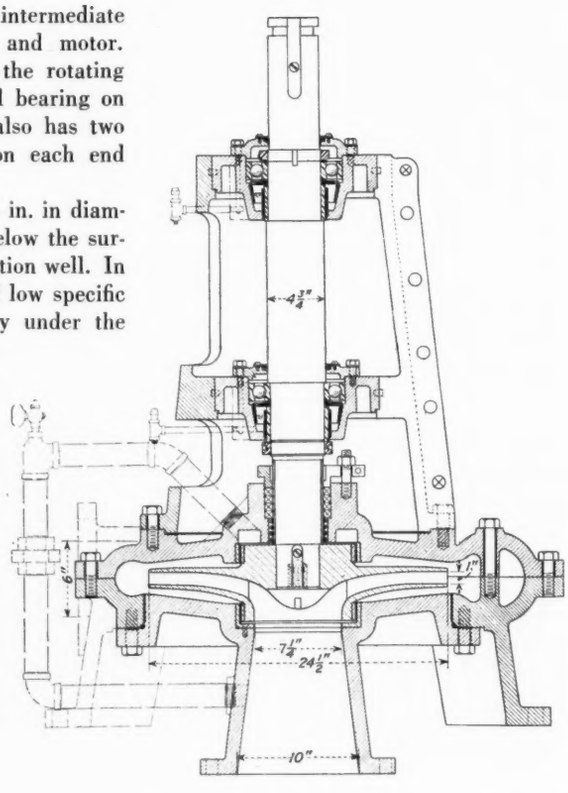
▶THE QUESTION is often asked: How high a head can a single-stage centrifugal pump be built for? Of course, the correct answer to this question depends upon several factors, but the pump described here will indicate what has been done. This pump was built and installed by the Newport News Shipbuilding and Dry Dock Co for ship-washing service and for standby fire protection. It is single-stage, vertical, single-suction, double-volute unit driven by a 2-speed, 450-hp, Westinghouse synchronous motor.

For ship-washing the pump operates at 1800 rpm, discharges 2000 gpm, and develops 650-ft head, 282-lb-per-sq-in. discharge pressure. This is an extremely high head for a single-stage pump. Its shutoff head is 668 ft, 290 lb per sq in.; consequently, the discharge head is practically constant between zero and 2000-gpm discharge. For standby fire service, the pump operates at 1200 rpm and delivers 1330 gpm against a 288-ft head, 125 lb per sq in.

As shown in the figure, the pump has two ball-guide bearings. A third ball-guide bearing is on the intermediate shaft between the pump and motor. Downward thrust load of the rotating element is taken by a ball bearing on top of the motor, which also has two ball-guide bearings, one on each end of the rotor shaft.

The pump impeller, 24.5 in. in diameter, is set about 16.5 ft below the surface of the water in the suction well. In addition, the impeller is of low specific speed and operates quietly under the extreme head conditions.

This unit is what would normally be called an 8-in. pump with a 10-in. suction, but most of the discharge and suction piping is 12-in. diameter to keep losses at a low value. Main piping goes to three docks where 84 connections for swivel nozzles are used for cleaning ship bottoms of marine growth in preparation for painting.



How to Build Big-Unit Efficiency into the Small Boiler Plant

Expansion to meet defense needs, or just to take care of better business, can be made to pay dividends if modern reliability and economy are engineered into the boiler plant. Joseph Breslove, Jr* shows by actual cases how to put big-unit ideas to work in the small plant

▶ TO MEET DEFENSE LOADS, many industries will be forced to expand boiler-plant capacity, either by new construction or by modernization, and never has the time been better. Building or modernizing today, the engineer can capitalize on more than 10 years of active development in fuel-burning and steam-generating equipment, can make necessary expansion pay dividends in greater reliability, easier operation, and higher efficiency. True, the most spectacular advances have been made in design of high-pressure, high-capacity plants, but recently similar improvements have been applied successfully to small boiler houses, bringing them close to central-station economy.

Modern Small Plants

What are the features of these modern small boiler plants? For one thing, the modern plant uses a smaller number of units than ever before; made possible by more reliable equipment and better operating methods, this practice tends to raise efficiency and lower first cost. A major share of the credit for increasing boiler reliability must go to improvements in methods of water treatment and deaeration. Proper treatment increases service life of pressure parts and reduction of scale-forming elements makes it possible to utilize high rates of heat transfer with safety as, for example, in the case of furnace waterwalls.

Waterwall construction, by reducing furnace temperature, improves operation of fuel-burning equipment, often permits use of lower grade fuels, and reduces cost of maintaining furnaces. Further, the cooling effect of waterwalls permits use of thinner brickwork or its complete replacement by a tilewall backed by insulation and a steel casing. The net result is often a cheaper, tighter, and easier-to-maintain wall, and a boiler that takes less building space and can be arranged with a high degree of flexibility.

Older units, consisting simply of a boiler set over a furnace, operated with all heat-absorbing surfaces under roughly similar conditions. Modern units consist of "specialized" heating surface; waterwalls absorb radiant heat directly at high rates, boiler surfaces absorb convection heat at moderate rates, and economizers and air heaters put the cooler gases to work most efficiently by transferring their heat to low-temperature substances such as combustion air and feedwater. The over-all result is greater heat transfer and consequently higher efficiency, without drastic increase in first cost.

Application of waterwalls parallels, to a great extent, increased use of pulverized-coal firing, but for the ordinary small plant the stoker offers greater flexibility and cleaner operation, as well as easier ash disposal. Addition of waterwalls to smaller units improves operation of underfeed stokers by reducing furnace temperature and attendant difficulties due to clinkering and the tendency of low-fusion coals to melt on the grates.

The recently developed spreader stokers seem particularly adapted to burning low-grade coals, such as the high-ash, low-fusion coals of Ohio, Kentucky, and Illinois. Because a large part of the fuel burns in suspension, these units respond quickly to load changes. On the other hand, ash and small carbon particles, carried through the boiler passes, tend to fill up the back of the boiler and the breeching and to scatter from the chimney top.

Difficulty in introducing and distributing air to burn both coal on the grates and in suspension often results in dilution of furnace gases with cold air; this effect, and that of carbon losses, accounts for the slightly lower efficiencies sometimes encountered with spreader units. On the other hand, ability to burn low-price coals and waste fuels may heavily outweigh efficiency differences. In any event, choice of firing equipment for a small boiler—whether

* *Mechanical Engineer with Joseph Breslove, Consulting Engr, Pittsburgh, Pa., and Cleveland, Ohio*

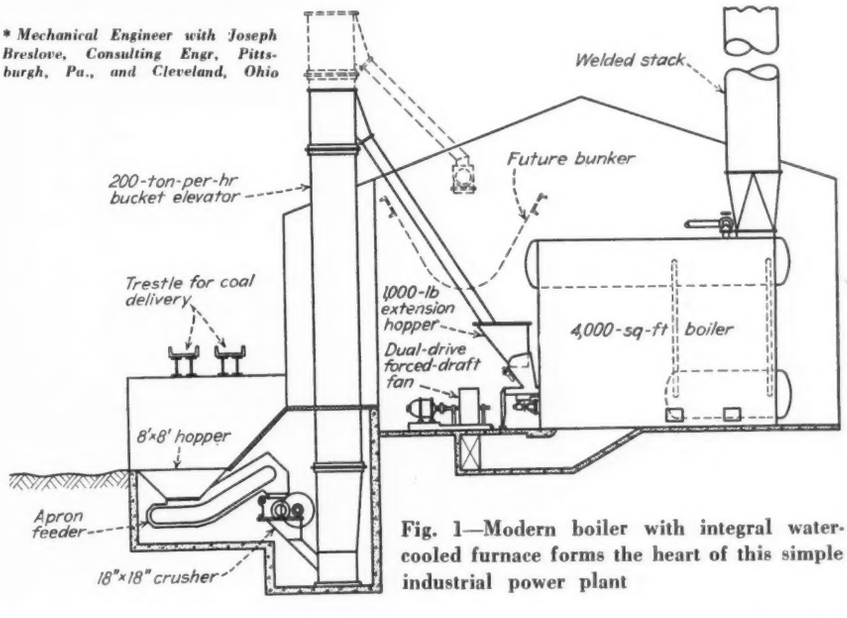


Fig. 1—Modern boiler with integral water-cooled furnace forms the heart of this simple industrial power plant

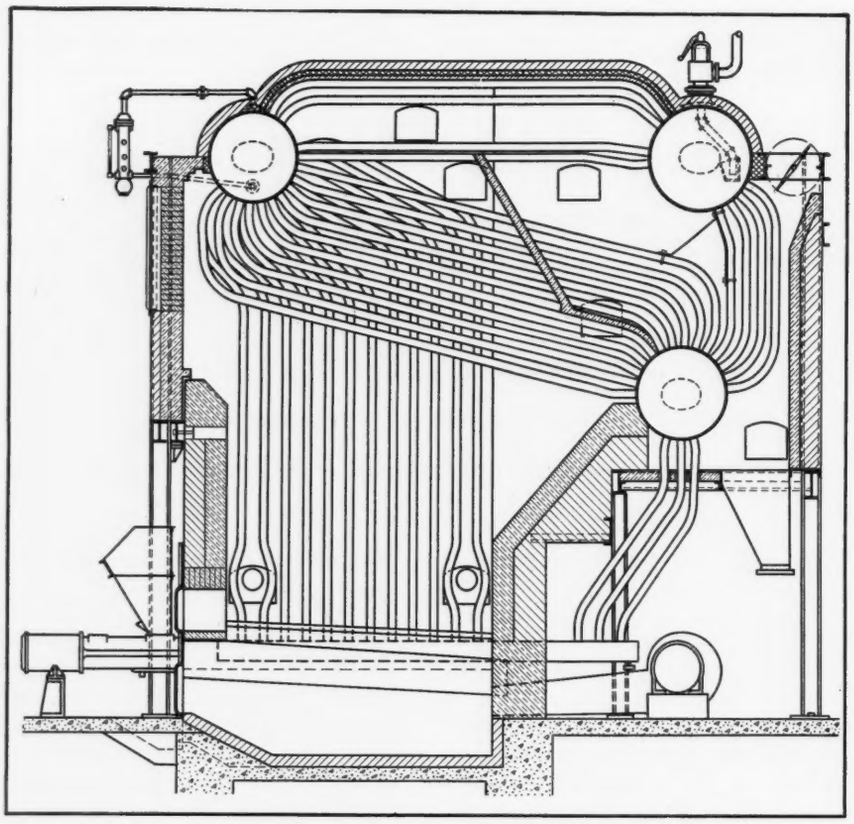


Fig. 2—Addition of side waterwalls increased output and improved stoker operation at Oswald & Hess, Inc, Pittsburgh, Pa. Front drum was extended sufficiently to connect with waterwall tubes which rise out of square headers at stoker grate line

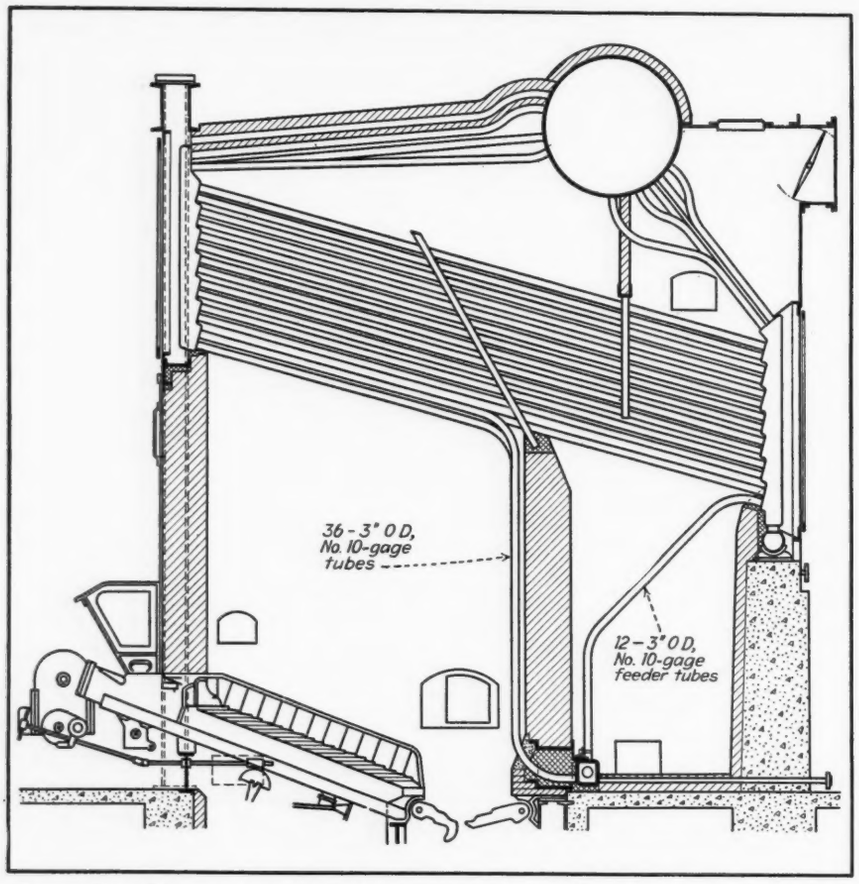


Fig. 3—Rebuilding stoker and adding water-cooled bridgewall boosted output by two-thirds at Pittsburgh City Home and Hospital. Also furnace maintenance has been reduced and corrosion practically stopped

multiple- or single-retort underfeed, chain or traveling grate, spreader, or pulverized coal, depends on a study of all the factors involved in any one case.

Developments outside the steam-generator also contribute to the modern boiler plant. Better materials and improved welding methods give us long flexible piping connections, reliable high-pressure joints, and the simplicity and lower maintenance of welded construction. Production of simple and reliable gages, instruments, and controls, at "small-plant" prices, makes it possible to operate modern units at sustained high efficiency with a minimum of attention.

Some actual cases, taken from several different industries with varied steam requirements, show how these modern boiler-plant improvements can be built into a new plant or, in many cases, fitted into an existing set-up. Fig. 1 shows the recently completed boiler plant of McCreary Tire & Rubber Co at Indiana, Pa. Here circumstances dictated an entirely new boiler plant with only a feedheater and spare feedpump temporarily retained from the old. The complete installation, containing but a single generating unit, was built for approximately $1.00 per lb of hourly steaming capacity.

In the vicinity of this plant, coal can be bought for approximately $1.25 per ton; it has many good characteristics, but its chief drawback is a low fusion point with the attendant tendency to clinker and run on the grates. Since underfeed-stoker firing was otherwise well adapted to the plant's needs, the engineers decided to install a single-retort underfeed stoker, depending on waterwalls to reduce furnace temperature and lower maintenance costs.

Single Unit Reliable

The factory operates 24 hr a day and 4 to 6 days a week. Reliability of modern units, coupled with weekend opportunities for inspection and repair, justified operation with a single boiler unit. This is a 4000-sq-ft Keeler CP boiler, fired by a Combustion Type E stoker 10 ft wide and 7 ft long, a proportion that best fits the characteristics of the coal to be burned. As can be seen from Fig. 1, all equipment within the mill-type steel building can be operated from the main floor; the few valves which could not be located within reach are equipped with chain wheels. This permits temporary operation without installing an overhead gallery as access is required only for inspection or repairs. Coal comes in on an overhead trestle, permitting extensive yard storage without requiring immediate investment in a bunker.

The water problem was perhaps the most difficult at this plant. Nearly all generated steam goes to noncondensing power or for processes which do not return condensate. Makeup, therefore, runs nearly 100% and the only water available for boiler feed is well water of 12 grains hardness. This is mostly carbonate hardness, which would indicate a hot-process softener, but for the capacity required the cost would be excessive. Zeolite softening, addition of sodium sulphate to maintain the sulphate-carbonate ratio, and 10% blowdown produce satisfactory results. Low fuel cost makes the large blowdown percentage relatively unimportant.

Waterwalls Added

An interesting example of waterwall application is furnished by the otherwise duplicate boiler units in the plant of Oswald & Hess, Inc, Pittsburgh. The earlier of the two, a 4500-sq-ft Union Iron Works low-head boiler, fired by a Jones twin-retort stoker, operates up to 200% rating. In adding the later unit it was considered desirable to duplicate the first boiler but to secure a more modern unit with greater capacity. Fig. 2 shows how the front drum was extended sufficiently to connect with waterwall tubes which rise out of square headers at the stoker grate line.

The fact that load is always carried on one boiler or the other affords an excellent comparison. The newer unit boasts greater capacity and easier operation; the cooler furnace permits high-rating operation without excessive clinkering and furnace maintenance has been virtually eliminated. Water cooling permitted thinner brick walls and elimination of silicon-carbide brick at the grate line, bringing cost of the second unit down to that of the first.

Pittsburgh city water, passed through a zeolite softener and deaerating heater, forms a nearly ideal feed for this boiler so that little secondary treatment is needed. No tubes have been lost in two years operation, in marked contrast to earlier experience, and it has never been necessary to shut down either unit except as scheduled. Before installing the second unit conditions made it necessary to operate one boiler continuously for a year, carrying entire plant load. At the end of this time no repairs were required beyond normal maintenance of furnace and stoker. To date, after a year's operation of No. 2 boiler, maintenance costs have been extremely low.

In many plants, existing boiler equipment can be remodeled to provide increased capacity, efficiency, and reliability, all at minimum cost. Fig. 3 shows one of two modernized units at Pittsburgh City Home and Hospital. These 6000-sq ft Springfield boilers, installed 15 years ago, are fired by 6-retort Westinghouse stokers. When generating over 30,000 lb per hr, each, draft loss became excessive for the existing stacks. Zeolite-softened water was available for the 60% makeup required, but contained excessive oxygen and corrosion was rapid.

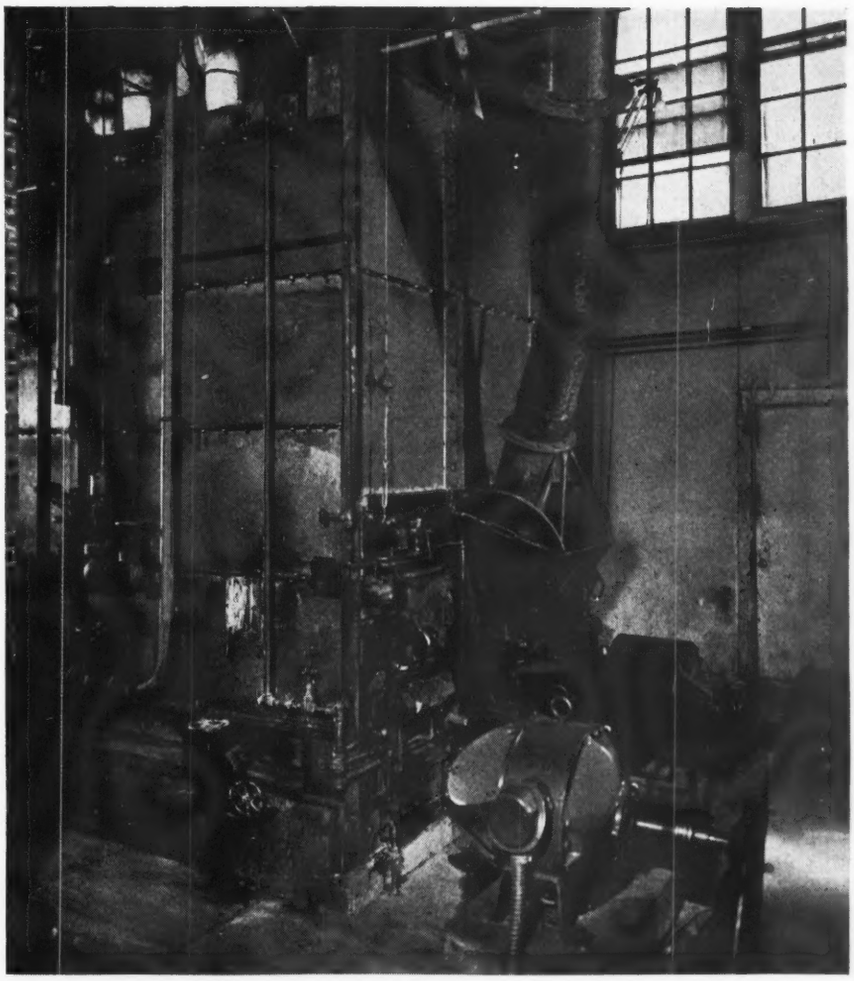


Fig. 4—Hospital-plant boiler, with integral water-cooled furnace and economizer

Modernization included rebuilding the stokers, adding water cooling to the furnaces, and installing a 150,000-lb-per-hr deaerator. Stoker retorts were deepened, a different design of tuyere was substituted and sidewall air blocks were added. New tubes, which pass over the furnace and then bend down to form a water-cooled bridge wall and clinker chill, replace the lowest two rows of boiler tubes.

The modernized units now carry loads as high as 50,000 lb per hr without difficulty, furnace maintenance has been reduced and corrosion has been practically stopped. Sometime after this change, a third Springfield unit was installed, similar to the modernized units but fired by a Westinghouse link-grate stoker. The lower end of the bridge-wall tubes forms an orifice for continuous ash discharge. The fully modernized plant can now carry its 95,000-lb-per-hr peak with any two of three available units; removal of a number of older boilers provides storage space.

In the boiler plant of the Monarch Rubber Co, Hartville, Ohio, choice lay between high-grade coals from the Pittsburgh and West Virginia districts, at about $3.50 per ton, and low-grade Ohio strip coal, at about $1.80 per ton. This coal does not lend itself readily to underfeed firing and cost of traveling grates for small units runs high. However, a spreader stoker will handle this coal without difficulty and this type of firing is well suited to follow the swinging loads characteristic of rubber mills. Country location renders production of flyash unobjectionable and it does not represent a nuisance as far as the process is concerned.

A Firite spreader stoker fires the 3000-sq-ft low-head boiler, burning the cheap Ohio coals in a high setting. Here over-all fuel economy far outweighs difference in efficiency between

(Continued on page 140)

Triple-Duty Plant Serves

In 50 years plant has grown from 40 to 4400 kva and now furnishes power to both the Institute and Blacksburg, Va., heats the campus and serves as a laboratory for students of power engineering

By J L DILWORTH

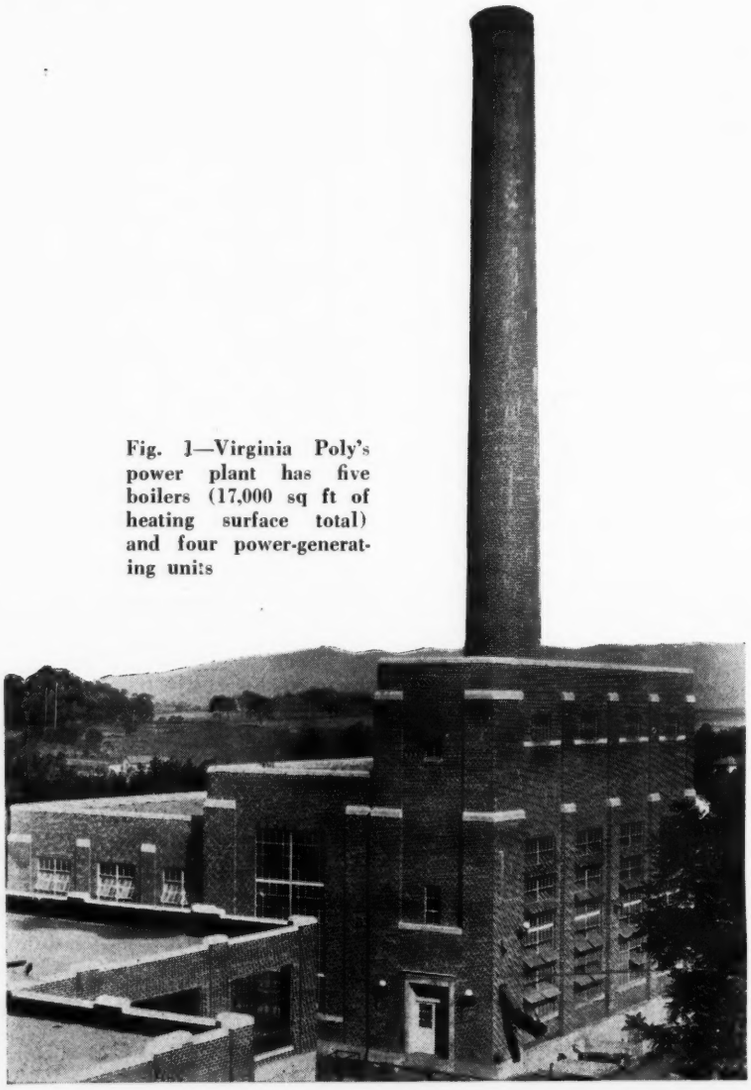


Fig. 1—Virginia Poly's power plant has five boilers (17,000 sq ft of heating surface total) and four power-generating units

▶A POWER PLANT serving several different functions simultaneously, such as the one at the Virginia Polytechnic Institute, has always been of interest to power engineers because of the unusual problems and possibilities it presents. This station, while it represents nothing spectacular, is an outstanding example of how capacity of a small plant can be increased at minimum cost without sacrificing efficiency.

The first power-generating unit put in operation by the college was a 50-hp steam engine with a belt-driven dc generator installed in 1891 after being hauled 10 miles on a wagon from what was then the nearest railroad. Even at that time the power plant served two purposes—the engine drove the machine shop by day and the generator by night. This unit was soon outgrown and as the years passed other units were added, 50-hp engines still being the order of the day.

In 1920, however, it was decided to install some real engines—two uniflow-engine-driven ac generators, one rated 120 and the other 200 kw, were purchased. These alternators were estimated to have ample capacity to supply the demand for years, but by 1928 it was evident that this estimate was grossly in error and plans were laid for building an entirely new plant. The new station was designed to accommodate a large increase in load. Four boilers were installed, two of 2500 sq ft and two of 3500 sq ft heating surface. A 780-kva turbine-generator was added to supplement the two uniflow-engine-driven generators from the old plant.

Fortunately, Prof W T Ellis, who was in charge of this work, had the foresight to insist that designers provide ample provisions for station expansion. His predictions as to the growth of the school were not long in being realized, for in 1935 more generating capacity was needed and a slightly used 1000-kva turbine-generator was purchased.

So rapid has been the expansion of the Institute, however, that during the winter of 1938-39 all four boilers were operating at around 200% rated capacity and the electrical load was so heavy that it was occasionally impossible to maintain the frequency above 59 cycles. This condition had been foreseen and an additional boiler and generating equipment were already being installed.

Primarily a power-generating station, this plant now has a gross generating capacity of 4400 kva, which is more than sufficient to furnish all the energy required by a college of around 3000 students and the town of Blacksburg which has a population of 3000 more. An equally important function of the plant is to furnish all of the heat required by the Institute. In addition to the actual heating of buildings, steam is required for hot water, dairy, laundry, laboratories, dining hall, kitchen and even a dry-kiln.

The plant was also designed to serve as a full-size laboratory for power-engi-

Virginia Polytechnic Institute

neering students. In addition to the instruction afforded to undergraduates in this plant, six fellowships are provided annually for graduate students who wish to specialize in power and fuels engineering. These students, under the guidance of Professor Ellis, head of the department, correlate their classroom work by standing regular 8-hour shifts as watch engineers and by working in the plant office.

The Big Problem

The big problem in operating a plant of this type is, of course, attaining the most economical and flexible combination between electrical and heating loads. Since there is no fixed relation between these two demands, the problem is not a simple one. It is obviously desirable to use only exhaust or bled steam for heating purposes, and it is similarly desirable not to exhaust to the atmosphere, especially because of the scarcity of suitable feedwater.

When an additional turbine was purchased four years ago it was necessary to exercise economy because of lack of funds. Partly for this reason we bought a non-condensing unit with the idea that the condensing turbine would supply all of the current required during the summer months when both the heating and electrical loads are relatively light. The load increased so rapidly, however, that this is no longer the case and during the past winter both machines operated at capacity. This was in part due to the fact that the non-condensing turbine was designed for 225-lb steam pressure and delivered only about 680 of its rated 1000 kw with a steam pressure of 165, the maximum of the old boilers. A critical aspect of the situation was that the demand was so heavy it was impossible to shut down either turbine for repairs.

The problem was, then, to obtain: (1) additional boiler capacity, (2) increased generating capacity, (3) greater condensing capacity, and, if possible (4) higher steam pressure for the 1000-kw unit. These were met by installing one new 5000-sq-ft boiler, designed to give 225-lb steam at the throttle, and by purchasing another condensing turbine-generator unit designed for this pressure. The boiler and stoker unit are new, and we were able to buy a 2500-kw rebuilt turbine at very low cost.

The flow diagram, Fig. 3, shows the flexibility which has been built into this plant. Boilers 1 and 2 were intentionally installed without superheaters because they primarily supply high-pressure steam for heating purposes. Should the occasion require it, however, saturated steam from them could be supplied into the superheated-steam header for No. 3 and 4 boilers.

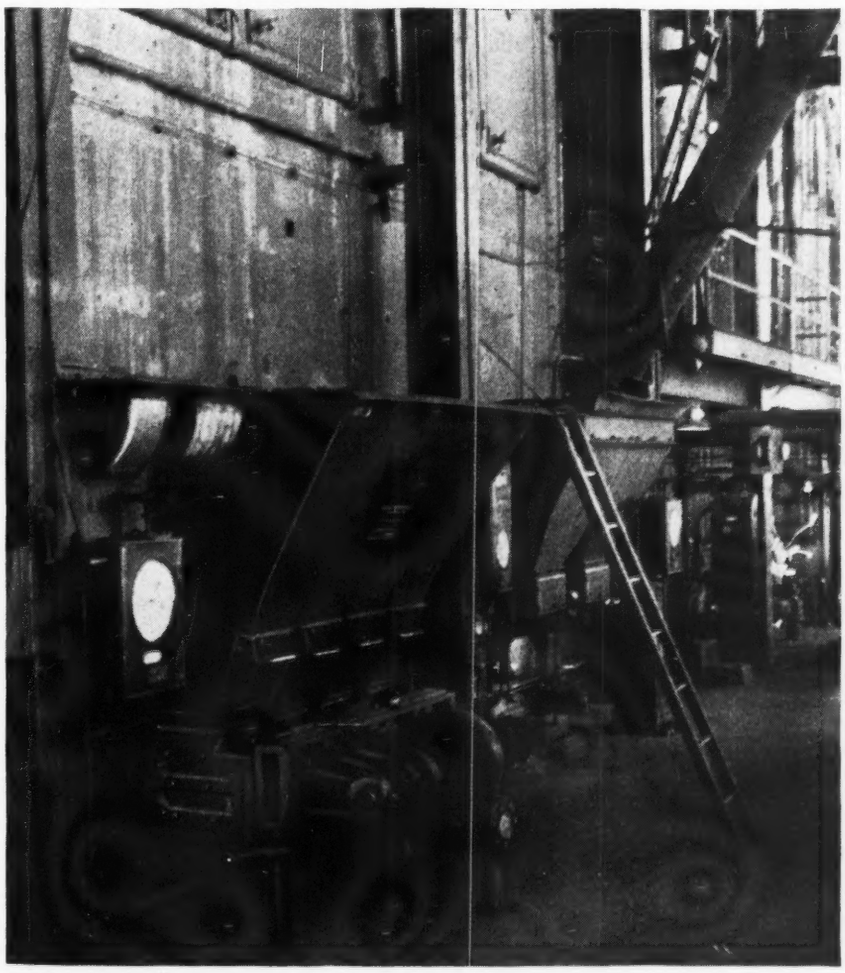


Fig. 2—Newest boiler (extreme right) generates steam at 250 lb, 545 F

New Boiler

The new steam-generating unit, having a working pressure higher than the older ones, could not be connected directly to the main header. Moreover, such an arrangement was not desirable because of the differences in pressure required by the various prime movers. Normally, No. 5 boiler will not be connected to the others at all, but will supply steam directly to the two larger turbines. A reducing valve is provided, however, so that steam can be diverted from the 225-lb to the 165-lb superheated-steam header if so desired. It will also be possible, of course, to run the non-condensing 1000-kw turbine on 165-lb steam when it is necessary to take the new boiler off the line. This arrangement permits great flexibility of operation, but the normal plan will be somewhat as follows:

During the heating season the 1000-kva non-condensing turbine will be operated at a load that will supply the amount of exhaust steam required by the low-pressure heating mains. Should the electrical load exceed 1000 kva, the balance can be obtained from either of

the other condensing machines as required. If more low-pressure steam as well as power is required, it would be secured by extraction from the small turbine. When heating load exceeds electrical, the extra steam can be obtained through the pressure-reducing valve from the saturated-steam header. During the summer months when heating load is very light, either or both of the condensing units may be operated. Such low-pressure steam as is required can be obtained by extraction and from the exhaust of steam-driven auxiliaries.

The Heating Circuit

A brief explanation of the heating circuit may be of interest. For obvious reasons low-pressure steam heats the buildings close to the power plant. We decided, however, that, considering the piping required, it would be more economical to use high-pressure steam for the more distant buildings, some of which are half a mile away from the plant. The pressures carried in the different mains vary from full-boiler, 165-lb to 50-lb, the lower pressures being obtained by reducing valves. The high pressures are further reduced at the various buildings to a value determined by atmospheric temperature.

The final reducing valves are controlled by an automatic steam-regulating system built by the Simplex Heating Specialty Co under the direction of Wiley & Wilson, consulting engineers. This device controls the pressure in the low-pressure heating main at the plant and actuates the reducing valves in distant buildings by remote hydraulic control. The regulator is operated by changes in atmospheric temperature, and has provision for manual correction in the event that such factors as wind velocity or humidity necessitate more or less heat than would be indicated by the dry-bulb temperature.

A comparative scarcity of boiler feedwater makes it necessary to return all condensate from the heating system to the hot well. Hot water is continuously circulated to all parts of the campus through a closed-loop system, which insures hot water in any building at any time.

The new boiler is a modification of the ring-circulation type with convection superheater and is fired by a multiple-retort underfeed stoker. Designed for a maximum pressure of 300 lb, the boiler will be operated at a pressure of 250 lb at the superheater outlet to give the 225 lb at the turbine throttle. Normal rating is 30,000 lb of steam per hr with a guaranteed maximum of 45,000 per hr for two hours with 215-F feedwater. Successful operation at high ratings is insured by 42-in. waterwalls on the sides of the furnace and by a water-cooled bridgewall and clinker chill. The bridge waterwall and clinker chill are protected by slip-on armor to a height of 32 in. Cast-on armor blocks are used on the header at the ash discharge. The 3-drum boiler has a total heating surface of 5000 sq ft including the water-cooled bridgewall. Automatic combustion control operates both stoker speed and forced-draft controls.

Ash is removed by steam-jet ash- and soot-handling equipment. While this system was installed with the other new equipment, it was extended to take care of the old boilers, from which ash was formerly removed by dumping from the ash hopper below each furnace into a small car. By these cars, ash was transported to an elevator which loaded it into a truck. Clinker grinders are being provided on the old units so that this system will remove the slag with the ash. Clinkers from the new furnace will be broken up and removed by hand.

Feedwater System

Boiler feedwater is supplied to the new unit by two multi-stage centrifugal pumps. One of these pumps is driven by an electric motor, and its discharge is controlled by a regulator. The other pump, of equal capacity, is driven by a governor-regulated turbine. The governor is actuated by boiler pressure so that the drop in steam pressure occasioned by a sudden rise in load will immediately increase the supply of feedwater, and vice versa. The feedwater regulator, of course, prevents undue change in water level under any circumstances.

The 2500-kva, 4-stage Curtis turbine, although quite old, has just been rebuilt

PRINCIPAL NEW POWER-PLANT EQUIPMENT

Virginia Polytechnic Institute, Blacksburg, Va.

Steam-Generating Equipment:
Boiler and waterwalls.....E Keeler Co
3-drum boiler, heating surface including waterwalls, 5000 sq ft; rated maximum continuous steam capacity 30,000 lb per hr, for 2 hr 45,000 lb per hr; design pressure, 300 lb g; working pressure 250 lb g; total steam temperature, 545 F
Superheater, convection.....E Keeler Co
Boiler settings.....J L Hamilton Engrg Co
Breechings.....Central Automatic Sprinkler Co.
Water-cooled bridge wall.....E Keeler Co
Clinker-chill slip-on armor.....E Keeler Co
Cast-on armor blocks.....Drake Non-Clinkering Furnace Block Co
Boiler heat insulation.....Johns-Manville Co; Eagle-Picher Lead Co

Combustion Equipment:
Stokers, multiple retort, underfeed.....Westinghouse Electric & Mfg Co
Projected grate area 96.7 sq. ft; normal continuous rating 3650 lb of coal per hr; maximum rating for 2 hr, 4700 lb per hr; continuous ash discharge. Stoker driven by 5-hp Westinghouse motor through Morse Chain Co silent chain and Reeves Pulley Co variable-speed transmission
Ash pit, drippage and sifting hoppers and windbox.....United Conveyor Corp
Automatic combustion control.....The Hays Corp
Soot blowers.....Diamond Power Specialty Corp
Steam-jet ash- and soot-handling system.....United Conveyor Corp
Forced-draft fan.....Clarage Fan Co
Forced-draft-fan motor, 25 hp.....General Electric Co

Piping, Valves and Fittings:
High- and low-pressure piping.....Bethlehem Steel Co
High- and low-pressure pipe bends.....Tube Turns, Inc
Pipe insulation.....Eagle-Picher Lead Co; Philip Carey Mfg Co
High-pressure valves.....Crane Co
Safety valves.....Manning, Maxwell & Moore, Inc
Blowdown valves.....Yarnall-Waring Co
Non-return valves.....Edward Valve & Mfg Co
Stop and check valves on feed lines.....Walworth Co
Reducing valves, remote pilot system.....Spence Engineering Co
Atmospheric relief valve.....C H Wheeler Mfg Co
Traps and strainers.....Illinois Engineering Co
Piping contractor.....Central Automatic Sprinkler Co

Feedwater System:
Feedwater heater, deaerating.....Cochrane Corp
Water columns.....Reliance Gauge Column Co
Feedwater regulator (Copes).....Northern Equipment Co
Feedwater pumps, 2, 100 gpm, 885-ft head....Worthington Pump & Mach Co
One Moore-steam-turbine driven and one Westinghouse-motor driven
Feed-pump pressure governor.....Fisher Governor Co

Meters and Instruments:
Steam flowmeters.....Cochrane Corp
Pressure recorder.....Cochrane Corp
Temperature recorders (flue gases).....The Hays Corp
CO_2 recorder and draft gages.....The Hays Corp
Pressure gages, indicating.....Crosby Steam Gage & Valve Co
Thermometer, dial.....Manning, Maxwell & Moore, Inc
Thermometers, indicating.....C J Tagliabue Mfg Co
Coal scales.....Fairbanks, Morse & Co

Power-Generating Equipment:
Turbine-generator unit.....General Electric Co
Steam conditions, 225 lb g, 545 F total temperature, 28.5 in. vacuum. 2500-kva, 0.80-pf, 2300-volt, 3-phase, 60-cycle generator
Condenser.....Ingersoll-Rand Co
Condensate pump, 90 gpm.....Ingersoll-Rand Co
Condensate-pump motor, 7½ hp.....General Electric Co
Condenser-circ-water pump, 4000 gpm, 875 rpm.....Ingersoll-Rand Co
Circulating-water-pump motor, 60 hp.....General Electric Co
Air ejectors.....Ingersoll-Rand Co
Cooling tower.....Foster Wheeler Co
Axial-flow fans.....Foster Wheeler Co
Fan motors, 10 hp.....Westinghouse Electric & Mfg Co

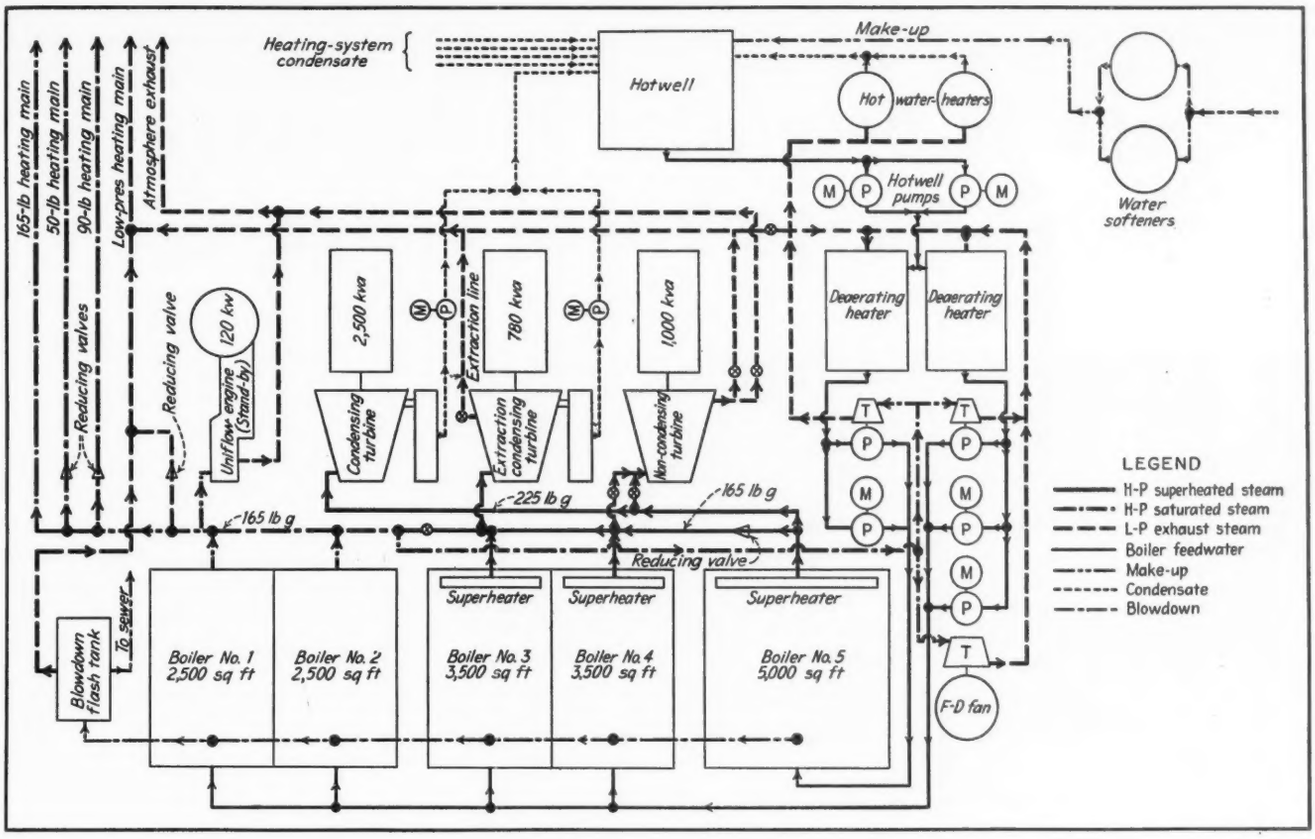


Fig. 3—Flow diagram of power-generating and heating system. Note five different pressure levels

and is in first-class shape. It was selected after careful consideration because of its cost, its excellent condition, and because it has ample capacity to take care of load growth for years to come. This unit replaced the 200-kw uniflow-engine-driven unit, which was needed by another state department. Because of its large size the installation of the turbine and its condenser in the allowable space required some nice handling and careful calculations. No difficulty was experienced, however.

The condenser for this turbine was likewise a piece of used equipment. It has been completely retubed, however, and is now as good as new in all respects. The old air ejector was replaced with a new one.

The plant has always had the disadvantage of being four miles from the nearest river, and hence the supply of condensing water is rather meager. This problem was met for some years by using a spray pond for cooling the recirculated condensing water. This proved inadequate and wasteful of water, so several years ago the cooling pond was replaced by a cooling tower, which has been so satisfactory that an additional unit was built to take care of the extra condenser.

All water used in the plant comes from springs, high in calcium carbonate. The boiler feedwater and the hot water for the campus (the latter being heated in a closed-type heater) is softened by two zeolite units. Air removal is accomplished by deaerating heaters. An additional heater was installed to take care of the feed for the new boiler.

Electrical equipment is typical of that found in most stations of similar size and requires no special elaboration. One noticeable advantage is enjoyed because no long-distance transmission is required, and hence power can be generated and distributed at 2300 volts without need for any intermediate transformation.

✦ ✦ ✦

Rounding Off Decimals

▶A NEW STANDARD for rounding off numerical values has been prepared by the American Standards Association. The most interesting feature of the new standard is that it emphasizes the correct rule for rounding decimals ending in 5. This method, used for some time in statistical work and in precise scientific calculations, is to round off to the even figure. Thus, 3.25 is rounded to 3.2; 0.215 to 0.22; 6.75 to 6.8.

The following illustration makes clear how the unscientific method of simply taking the next higher figure leads to cumulative error. Let us divide the odd numbers from 1 to 13 by 2, then round off the quotients by each of the two methods, add, and multiply by 2. The problem is:

$(0.5 + 1.5 + 2.5 + 3.5 + 4.5 + 5.5 + 6.5) \times 2 = 49$

By the incorrect method (taking the next higher figure) we have:

$(1 + 2 + 3 + 4 + 5 + 6 + 7) \times 2 = 56$

By the correct method (rounding to the even figure) we have:

$(0 + 2 + 2 + 4 + 4 + 6 + 6) \times 2 = 48$

The error in rounding by the correct method is but 1, while by the incorrect way it is 7.

Copies of the new standard (Publication Z25.1-1940) are available from the American Standards Association, 29 W 39th St, New York, N. Y., at a cost of 20 cents per copy.

How to Determine Performance of Engine-Driven Pumps

By A J Stepannoff

Cameron Engineering Dept, Ingersoll-Rand Co

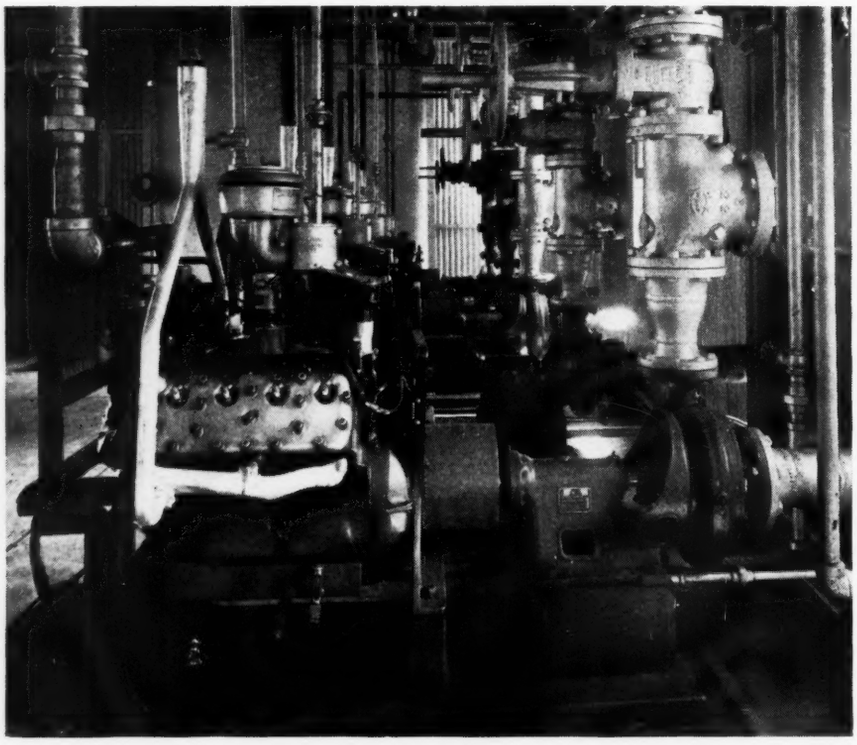


Fig. 1—Five circulating-water centrifugal pumps driven by gasoline engines

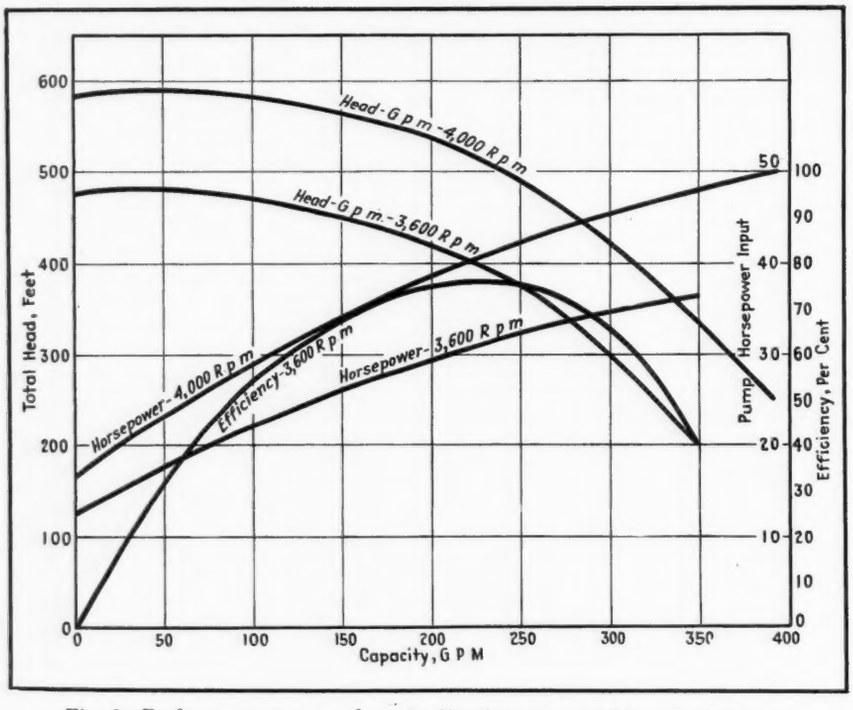


Fig. 2—Performance curves of a centrifugal pump at 3600 and 4000 rpm

▶ The problem of determining maximum performance of centrifugal pumps, when driven by motors, is relatively simple because the speed of these driving units remains practically constant under various load conditions. With gasoline- or diesel-engine drives, complications set in because the power of these engines varies with speed. However, to gain a clear and complete understanding of the problem, we will consider first motor drive.

Assume you have a pump hooked to a constant-speed motor. Speed varies little with load unless the motor is seriously overloaded. Fig. 2 shows the characteristics of a centrifugal pump good for 225 gpm at 400-ft head, requiring 30.5 hp to drive it at 3600 rpm. If pump speed is held constant and head increased to 450 ft, capacity drops to 150 gpm and driving power falls off to 26.5 hp.

Conversely, if head drops to 300 ft, pump discharge increases to 300 gpm and driving power required climbs to 34.5 hp. The motor driving this pump will take power from the line in proportion to the increased or decreased power required by the pump.

Speed Increase

Now, consider what happens when the pump is speeded up from 3600 to 4000 rpm. Pump capacity increases as its speed, head as the square of its speed and driving power required goes up as the cube of its speed.

In this example, speed is increased in the ratio of $4000 \div 3600 = 1.11$. Then, pump capacity climbs 1.11 times. Pump head increases as the square of the speed, or $1.11 \times 1.11 = 1.23$. Referring back to the original pump data in the second paragraph, you find that the 225-gpm capacity becomes $225 \times 1.1 = 250$ gpm and the head is $400 \times 1.23 = 492$ ft. Thus, the pump

now has a capacity of 250 gpm at 492-ft head. By calculating the capacity and head for a number of points, you can plot the head-capacity curve for the 4000-rpm speed, see Fig. 2.

Power needed to drive the pump increases in proportion to the cube of the speed ratio, or $1.11 \times 1.11 \times 1.11 = 1.37$ times. Under the former conditions, power requirements were 30.5 hp; now, it is $30.5 \times 1.37 = 42$ hp. By calculating a series of horsepower values for the higher speed, you can plot a new horsepower curve, see Fig. 2.

Pump efficiency remains practically unchanged, but maximum efficiency, instead of being at 225 gpm, shifts to the right to 250 gpm, Fig. 2.

Engine Drive

Now, consider an engine-driven pump. If pump head changes so that power required to drive it increases, the engine will slow down if the throttle is in a fixed position. Engine power decreases with speed, but power required to drive the pump drops much faster, and the unit quickly reaches a speed at which both engine and pump power are equal. On the other hand, if head changes so that pump power decreases, the engine speeds up and causes the pump power to increase. Here again an operating point will be reached at which both engine and pump power are equal.

If the engine has sufficient power to meet any load requirement at constant speed, a constant-speed governor may take care of any change in power requirement by adjusting the engine-throttling opening. In practice, however, it is often desirable to utilize all power available from the engine at any speed, as for example, on fire engines. In this case, changes in head result in speed changes, which in turn vary power and capacity.

The trial and error method is a tedious way of finding the best operating point for the engine-pump unit. Much better is the following direct simple method of plotting a variable-speed, head-capacity curve for the pump when engine-power and -speed curves are available. Fig. 3 shows an engine horsepower curve and Fig. 4 pump-performance curves for constant and variable speed. The variable-speed curves are calculated to utilize all available engine power and results are given in the table.

Now, suppose you select an engine with the power curve of Fig. 3 to drive a 225-gpm pump at 3600 rpm and 400-ft head. Under these conditions, the pump requires 30.5 hp to drive it, as shown on the constant-speed performance curve, Fig. 2. The lowest engine speed at which this power is available is 1800 rpm. Then, the engine must be connected to the pump through a 1-to-2 speed increaser. The 1800-rpm engine speed and 3600-rpm pump speed will be referred to as normal, as it is at these speeds that the selection was made to meet a specific condition. Any speed, however, can be selected as normal when it is known that pump and engine powers are equal at the speed chosen for the particular problem in hand.

If engine speed is increased to 2000 rpm to obtain greater pressure from the pump, the latter will operate at 4000 rpm. From previous calculations for Fig. 2 it was found that at 4000

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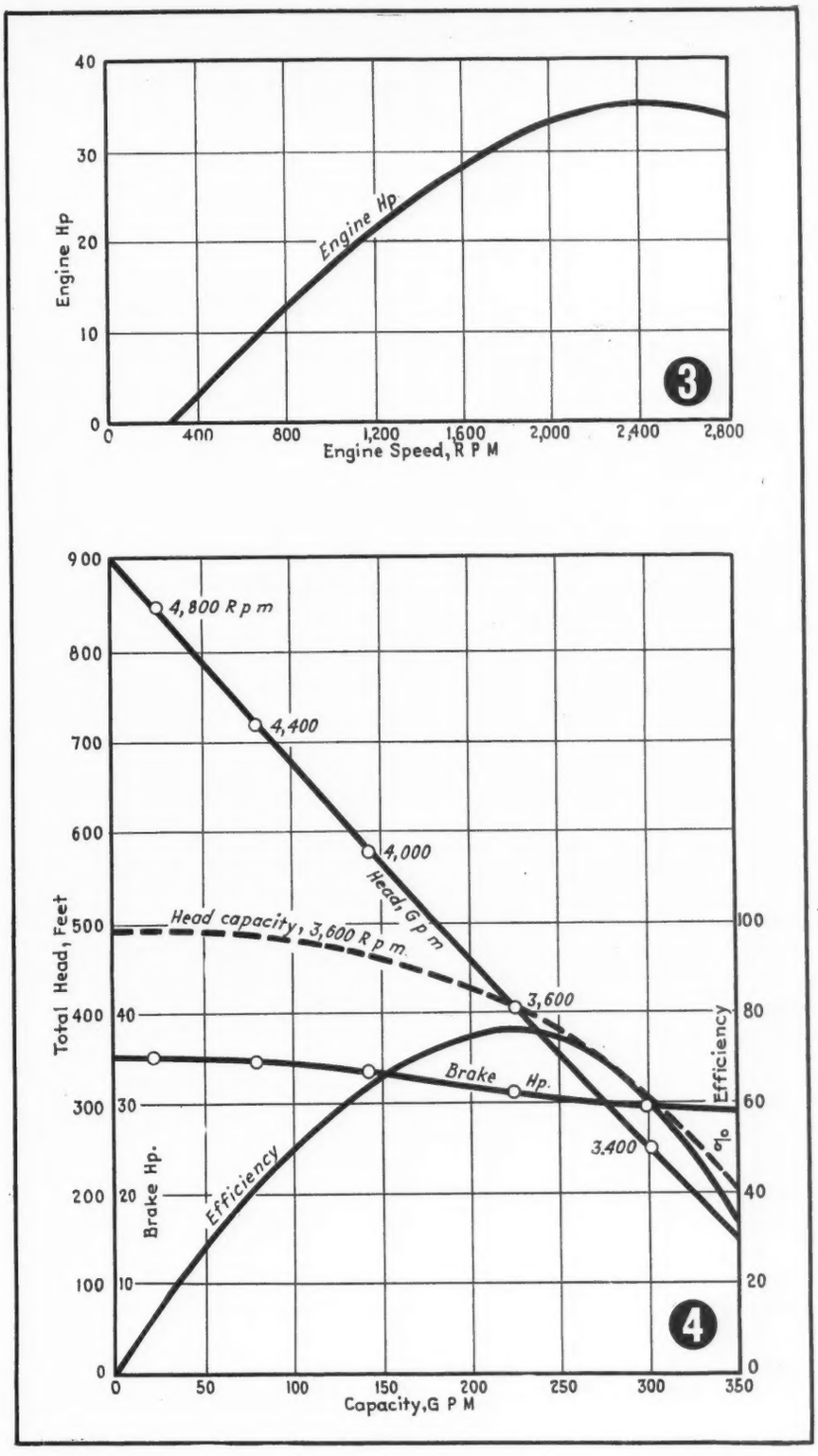


Fig. 3—Internal-combustion-engine speed and horsepower curve. Fig. 4—Performance of engine-driven centrifugal pump when speed is changed

Year's Service Record Shows Gas-Diesel Economy

Reporting on performance of 8-cylinder, 21x29-in., 225-rpm unit at Coolidge Standby Generating Station, R G Hornberger discusses reasoning behind selection and gives complete operating and cost data for first year's service

▶ THE SAN CARLOS IRRIGATION PROJECT, U. S. Indian Irrigation Service, recently completed the first year's operation of an engine-driven generator unit, powered by a prime-mover of relatively new type. This engine burns either fuel oil or gas; combustion takes place on a true diesel cycle. Conversion from one fuel to another is simple and the change may be made quickly. This article outlines the reasoning leading to selection of this unit and presents data from the operating records of the first year.

A hydroelectric generating station at Coolidge Dam, and the diesel plant, known as the Standby Generating Station, supply the project power system. Additional power, as required, is purchased from outside sources. A system of 66-kv lines connects the two project generating stations, which supply an extensive system of 12-kv lines and several large individual loads. Project pumping load comes from 86 deepwell turbine pumps driven by induction motors with ratings from 40 to 150 hp; commercial load includes mines, industries, three towns, one REA project, and rural customers.

Plant Background

As originally contemplated, the Standby Generating Station was to operate about 5 months of the year to supplement Coolidge Dam power, but drought conditions since 1936 required almost continuous operation. Maintenance of important project pumping saved large acreage of crops which might otherwise have been lost because of an insufficient supply of gravity water in the project reservoir.

The two 932-kw engine-generating units originally installed in the diesel plant proved inadequate for the growing pumping and commercial loads. Plans and specifications for an addition were started in March 1938 and on July 7, 1938, a contract was entered into for the additional unit described in this article. The generating station building was extended, the foundation was constructed and the unit was installed during the winter of 1938-39. The engine-generator first started on June 1; after testing, it went into regular service on July 8.

Shortly before the new unit was authorized, the utility supplying gas to southern Arizona laid a line close to the plant, making natural gas available. A 5-year contract was negotiated with the company for gas at a rate of approximately $0.20 per million Btu, highly advantageous compared to current fuel-oil prices. However, the importance of the load, particularly project pumping, made it seem undesirable to install a unit able to operate only on fuel secured from one source. Consequently it was decided to call for bids on engines which could be converted from gas to fuel-oil operation.

The advertisement for bids made provision for evaluation between bids on the basis of the relative cost of the two fuels; time required to change from one fuel to the other was also considered. For administrative reasons connected with the release of irrigation water, extra power could be secured from the hydroelectric plant for only approximately 4 hours. Thus, installation of gas-storage equipment was considered necessary for any engine requiring more than 4 hours for conversion and this fact was recognized in considering the bids. It is believed, however, that under the usual operating conditions more than 4 hours will be available for change-over, particularly when it can be anticipated.

Engineers of the Indian Irrigation Service follow a consistent policy, in purchasing mechanical and electrical equipment, of adhering to conservative ratings. Consequently, the advertisement and contract made provision for derating the engine from the manufacturer's published rating. This was accomplished by limiting the BMEP to

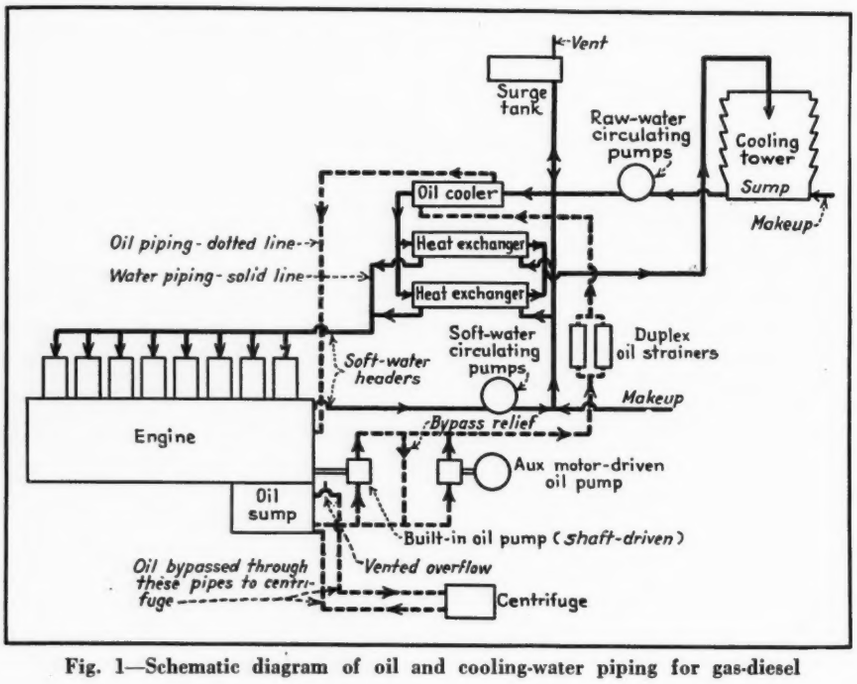


Fig. 1—Schematic diagram of oil and cooling-water piping for gas-diesel

60 lb per sq in., with the further provision that it should not exceed 90% of the rating published by the manufacturer. Rotative and piston speeds were also definitely limited. It is firmly believed that this course resulted in decreased maintenance and increased reliability for this engine as well as for the other equipment to which the policy has been applied.

The engine purchased is a Nordberg, 8-cyl, 21x29-in., 2-cycle, cross-head unit, direct connected to a 225-rpm, 2400-volt, 3-phase, 60-cycle, 2500-kva Elliott generator. Table I gives specification data for the engine. Fiat valves control scavenging, and a Roots-Connersville positive-displacement blower, gear driven from the engine shaft, furnishes scavenging air. Intake air enters through an automatic viscous-impingement filter.

Separate soft- and raw-water systems cool the engine, see Fig. 1. The soft-water circuit includes the engine jackets, circulating pumps, and heat exchangers; a surge tank, in the building roof structure, takes care of changes in volume, but there is no circulation through the surge tank. Elimination of an open sump in the soft-water system avoids constant head loss due to differences in elevation of sump and engine; the entire soft-water circulating-pump load consists of hydraulic friction. All makeup for the soft-water system comes from a zeolite softener.

Raw-Water Circuit

The raw-water circuit includes heat exchangers, circulating pumps and a cooling tower, designed for a 5-F approach to wet-bulb temperature with a 2-mile wind. Relative hardness of raw water (about 30 grains per gal., expressed as calcium carbonate) necessitates frequent cleaning of the heat exchangers. Presence of fine wind-borne dust, almost colloidal in nature, which is deposited in the cooling-tower sump, further complicates cleaning. Operators now successfully clean the sump, without interfering with tower operation, by using a small pump fitted with a suction hose and nozzle like that of a vacuum cleaner. Exchangers were selected with approximately 60% excess surface, on a clean basis.

A shaft-driven pump continuously circulates lubricating oil through a cooler; an auxiliary motor-driven pump stands by for starting-up and emergencies. A centrifuge continuously conditions a portion of the lube oil by means of a partial bypass. It is planned to supplement the centrifuge with a filter to secure removal of colloidal materials.

The fuel system for operation on oil is conventional solid-injection, with individual Bosch pumps for each cylinder. Injection nozzles are water-cooled. Since a high degree of reliability and long runs without shutdown are required by the nature of the operation, it has been found desirable to use a completely distilled fuel with a gravity ranging from 27 to 32 deg API and a viscosity of 35 to 55 (SSU at 100 F). Performance of the engine on such fuel during trial periods was excellent.

Fuel gas is received at a pressure of 30-50 lb, as established by contract. A 3-stage compressor, of conventional design and provided with adequate stage coolers, raises gas pressure to 1050-1200 lb. Injection valves similar to those on an air-injection engine control admission of compressed gas to the cylinders. The valve plungers are hydraulically operated by oil from the fuel pumps so that the governor, which controls the fuel pumps, regulates the lift of the injection valves. Under this method of operation, oil in the lines between fuel pumps and valve-operating cylinders does not circulate except for a slight amount of leakage; a water jacket cools these lines.

It would have been possible to design this engine in such a manner that the 3-stage gas compressor could have been used for compressing air, thus permitting air-injection and use of heavy oil. However, this would have resulted in a considerable loss of energy under normal gas operation, since gas is received at a pressure of at least 30 lb g and would have required a normal input to the compressor of at least one-third more than at present.

Nordberg engineers have found, in developing this engine, that it is necessary to add pilot oil—that is, inject a spray of oil with each charge of gas. This oil apparently controls the flame propagation and insures burning instead of detonation. The amount of pilot oil is not critical, and has amounted, for the year's operation, to approximately 5.7% of the total heat energy in the fuel. A small auxiliary multiple Bosch fuel pump handles pilot-oil injection. The quantity does not vary with change of load, which explains the wide variations in quantities of pilot oil, as given in Table III.

The contract specified that the engine should be capable of 15% overload for a short period. This overload consideration established the normal rating of the engine when operated on gas. However, it has been found by experience that this rating can be greatly exceeded for short periods. In emergencies this unit has carried an average load of 2200 kw for two hours and a short-time load of about 2300 kw, a 35% overload.

Engine Conversion

Conversion proved relatively simple, involving only changing injection nozzles and connecting or disconnecting the compressor drive. Provision for disconnecting the compressor connecting rod and holding it in the upper position simplifies this change. Design of cams facilitates the change of setting found desirable when switching fuels.

On June 1, 1939, the engine started initially, on oil. A shakedown run and a 60-hr full-load run followed, with formal acceptance tests on June 24. The engine was then changed to gas and first run on June 26. After a shakedown run on gas, formal acceptance tests were made on July 7 and 8 and regular operation was started July 8.

Extreme care marked the acceptance-test procedure. The contract specified an over-all performance that could be easily and accurately measured in terms of fuel input and electrical output. Fuel input was measured by scales in the case of oil and calibrated meter in the case of gas. Rotating standard watthour meters measured output. In all, approximately 6000 individual readings were

TABLE I

Generating-Unit Specification Data

Engine rating, oil fuel, hp	2700
Engine rating, gas fuel, hp	2430
Net rated unit output, oil, kw	1893
Net rated unit output, gas, kw	1700
Number of cylinders	8
Bore and stroke, in	21x29
Revolutions per minute	225
Mean piston speed, fpm	1088
BMEP, oil fuel, psi	59.1
BMEP, gas fuel, psi	53.4
Piston cooling: forced-circulation, lubricating oil	
Lube oil circulated, gpm	240
Normal rise, lube-oil temp, F	30
Circulation rate, soft-water system:	
Design requirement, gpm	680
Pump capacity provided, gpm	820
Normal rise, soft-water temp, F	20
Heat-exchanger surface, sq ft	1170
Oil-cooler surface, sq ft	950
Starting-air pressure, psi	250
Scavenging blower, type	Roots
Scavenging-blower drive	gear
Scavenging-blower speed, rpm	900
Scavenging capacity, cfm	14,400
Scavenging pressure, rated psi	2.25
Flywheel diameter, in	84
Flywheel weight, lb	14,300
Flywheel WR^2, lb-ft^2	102,000
Main bearing, size, in	17x12
Crankpin-bearing size, in	14.75x8.5
Governor	Woodward, Type IC
Ratio, foundation to engine wt	2.25

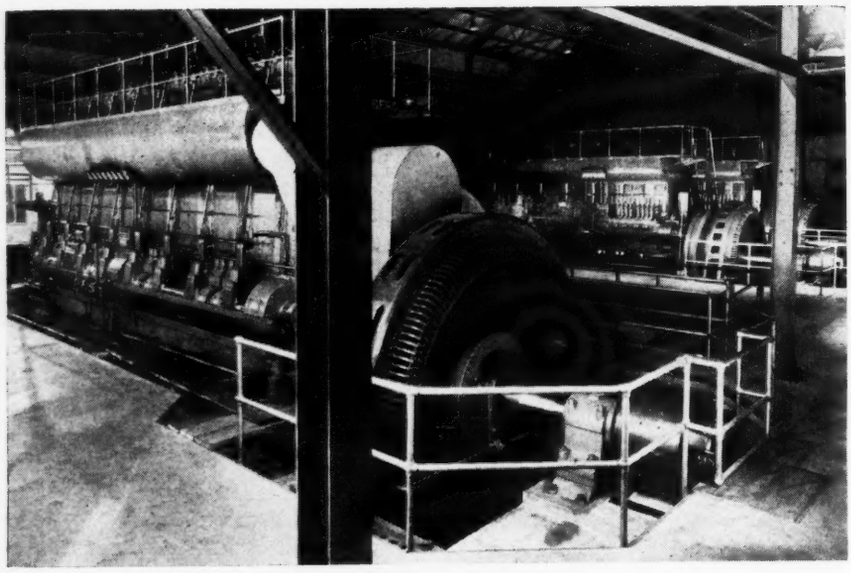


Fig. 2—Gas-diesel in foreground; two 932-kw diesels in background

taken and important instruments were calibrated after the tests. In general, procedure followed recommendations of the ASME Power Test Code.

The contract guaranteed an input of 10,680 Btu per net kwhr of output, on oil fuel, and 12,470 Btu on gas, at full load. The corresponding test values were 10,300 and 10,900, representing an improvement over contract of 380 and 1570 Btu for oil and gas fuel respectively.

Table II shows operating pressures and temperatures taken from a typical station log sheet and selected for a time when the load had averaged 1700 kw for two hours. Table III shows engine duty in terms of hours run, output, average load, engine-service factor, and running-engine capacity factor, tabulated by months for the year from Aug 1, 1939, to July 31, 1940. The table gives the formulas for engine-service and running-engine capacity factor; these follow roughly the definitions used in the ASME Oil and Gas Power Division's "Power Cost Report."

The overloads constitute a notable feature of the year's operations. From Aug to Nov, inclusive, the engine ran 96.4% of the time at 102% of rated load. All concerned recognized that such operation was not desirable but project funds were low, water storage in the reservoir was inadequate, and it was necessary during this period to purchase 2,353,000 kwhr from outside sources. It was, therefore, imperative to secure maximum production. It is probable that the cost of any repairs necessitated by this was less than comparable cost of purchased power.

In December and the first part of January, minor mechanical troubles cropped up, as a result of the overloading. As project load had fallen off, the engine was checked thoroughly and reconditioned where necessary, during the period from January 11 to February 12. After a short period of running on oil, it went back into gas operation on February 26 and has continued on gas until the present.

Minor Adjustments Made

During the shutdown period, minor mechanical adjustments were made and some parts replaced. It will be noted that this is the third engine of this particular type produced by this manufacturer. The first two engines operate in a plant where load permits periodic shutdown for inspection and servicing. Character of the project load makes even a momentary shutdown highly undesirable for periods of several hundred hours. It was found that parts which might normally work with entire satisfaction under oil lubrication had to be changed over to grease lubrication, with provision for application during operation. During the shutdown period, minor details of construction which had been left unfinished were completed.

Contract specifications required that the engine be equipped with an efficient muffler and scavenging-air silencer. Those furnished functioned well in reducing neighborhood noise to a satisfactory level and noise in the plant was not excessive or unusual for equipment of this type. It was found, however, that one of the engine noises was of such frequency as to affect operator's ears and to interfere with their use of the telephone. A checkup located the source in the scavenging-air system. Application of standard acoustical materials to the blower and insulation to the piping solved the difficulty.

Table III gives the performance of the engine with respect to fuel and lubricating-oil consumption. The fuel economy for the entire year's operation, 11,787 Btu per kwhr, betters the contract guarantee at 100% load by 5.5%.

The gas-diesel operates in the same

TABLE II—OPERATING TEMPERATURES AND PRESSURES

Cylinder No.	*Cylinder-Cooling Water—Outlet Temp, F*	*Piston-Cooling Oil—Outlet Temp F,*	*Exhaust-Gas Temp, F*
1	103	125	405
2	104	124	410
3	102	122	390
4	103	135	400
5	103	128	400
6	102	125	410
7	103	121	390
8	102	122	400
Average	102.8	125.3	400.6

Soft water	Into heat exchangers, F	101
	Out of heat exchangers, F	82
Raw water	Into oil cooler, F	61
	Out of oil cooler into heat exchangers, F	70
	Out of heat exchangers, F	85
Lube oil	Into oil cooler, F	121
	Out of oil cooler, F	91
Room temperature, F		83
Gas pressure	After low-pressure stage	148
	After intermediate-pressure stage, psi	530
	After high-pressure stage, psi	1110
Scavenging-air manifold pressure, psi		2.11
Soft-water pressure at engine, psi		22
Lubricating-oil pressure	Before filter, psi	42
	After filter, psi	26

plant as the two 932-kw diesel engines and the same personnel attends it. Maintenance and operation charges go to separate accounts but each is charged against the plant rather than against the separate engines. Thus no costs for operation and maintenance of the gas-diesel alone can be presented; the table gives cost in mills per kwhr for operation and maintenance of the plant, and percentage of output produced by the gas-diesel. Fuel costs given are for the gas-diesel only and averages are for the period covered, from Aug, 1939, through July, 1940.

Maintenance costs for Jan, Feb, and March run high because the first two months carry the cost of reconditioning the new engine after the long overload run, and the March figure includes reconditioning one of the smaller engines. The Jan and Feb figures are also affected by the low output in kwhr for those months.

The costs given do not include fixed charges, such as interest on the investment. Such charges are made on the project accounts but the project office is now reviewing rates of depreciation to be used to conform to the uniform accounting plan sponsored by the Federal Power Commission, and the figures are not yet available.

Operation Satisfactory

This article has attempted to discuss frankly and fairly the experience over a period of a year, with a new type of prime mover. In particular, a fuel cost of 2.35 mills per kwhr for a year's operation represents splendid fuel economy. It seems clear that the gas-diesel is an entirely suitable form of internal-combustion engine for use wherever an economical supply of gas is available and is particularly desirable because of its ability to operate on an alternate fuel in case of interruption to the gas supply.

The San Carlos Project of the Indian Irrigation Service is one of the activities of the Dept of the Interior. The Indian Office, headed by John Collier, Commissioner of Indian Affairs, directs activities of the Indian Service. A L Wathen, Director of Irrigation, supervises irrigation work, including power and pumping. The San Carlos Project is in charge of C J Moody, Senior Engineer. C J Wells, Power Superintendent, furnished many of the data used in this article. The generating station has been in charge of R D Cochran, Foreman Power House. R G Hornberger, the writer, is Senior Electrical Engineer and was actively engaged in preparation of equipment specifications and plant designs.

TABLE III—OPERATING RESULTS

Engine Duty

Month, 1939	*Hours Run*	*Percent of Time Run*	*Kwhr Generated*	*Average Load, Kw*	*Engine Service Factor* [1]	*Running Engine Capacity Factor* [2]
Aug.	744	100	1,291,300	1736	102.1	102.1
Sept.	645	89.6	1,236,100	1916	101.0	112.7
Oct.	718	96.5	1,332,400	1856	105.3	109.2
Nov.	714	99.2	1,266,400	1774	103.5	104.3
Dec.	560	75.3	965,600	1724	76.3	101.4
1940						
Jan.	248	33.3	422,100	1702	33.3	100.1
Feb.	67	9.6	58,000	866	3.2	50.9
March	734	98.7	1,118,000	1523	88.4	89.6
April	718	99.7	1,185,400	1651	96.8	97.1
May	744	100	1,300,000	1747	102.8	102.8
June	711	98.8	1,207,000	1698	98.6	99.9
July	722	97.0	1,206,000	1670	95.4	98.3
Avgs. and Totals [3]	7,325	84.9	12,588,300	1719	84.3	101.1

(1) *Engine Service Factor* $= \dfrac{\text{Engine output in gross Kwhr} \times 100}{\text{Rated Kw} \times \text{hours in period}}$ *(per cent)*

(2) *Running Engine Capacity Factor* $= \dfrac{\text{Engine output in gross Kwhr} \times 100}{\text{Rated Kw} \times \text{hours operated}}$ *(per cent)*

(3) *Amounts are not included for approximately 110 hours on fuel oil during February*

Fuel and Oil Rates

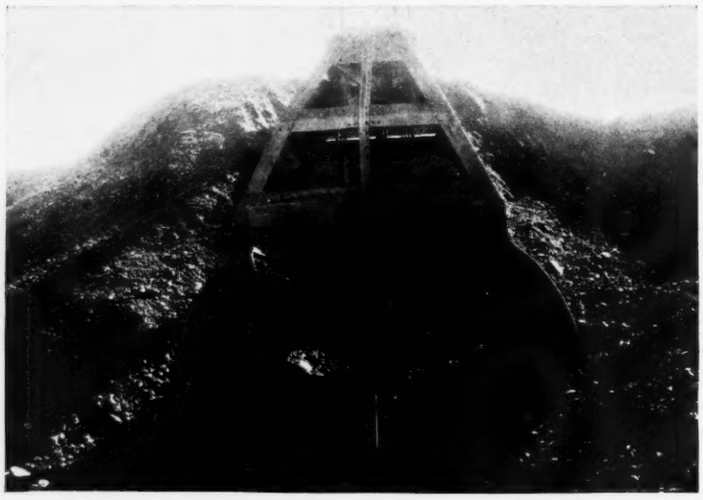
	Gas Fuel		*Pilot Oil*					*Lube Oil*	
Month, 1939	*Kwhr Generated*	*Cu Ft x 1000*	*Btu, Millions*	*Gal*	*Btu, Millions*	*Total Btu, Millions*	*Btu, per Kwhr*	*Gal*	*Kwhr per Gal*
Aug.	1,291,300	11,978	12,649	5,626	791	13,440	10,408	281	4,595
Sept.	1,236,100	11,769	12,451	4,819	678	13,129	10,621	261	4,736
Oct.	1,332,400	12,815	13,542	4,257	599	14,141	10,613	271	4,917
Nov.	1,266,400	12,219	12,938	5,433	764	13,702	10,820	277	4,572
Dec.	965,600	9,349	9,893	8,596	1,209	11,102	11,498	206	4,687
1940									
Jan.	422,100	4,095	4,335	3,210	451	4,786	11,339	86	4,908
Feb.	58,000	730	774	1,043	147	921	15,897	60	967
March	1,118,000	11,048	11,711	5,130	721	12,432	11,120	514	2,175
April	1,185,400	12,225	12,959	4,942	695	13,654	11,518	525	2,258
May	1,300,000	13,239	14,033	4,519	635	14,668	11,283	517	2,515
June	1,207,000	12,946	13,723	4,921	692	14,415	11,943	473	2,552
July	1,206,000	12,898	13,672	4,688	659	14,331	11,883	466	2,588
Averages and totals	12,588,300	125,311	132,680	57,184	8,041	140,721	11,787	3,937	3,197

Operation, Maintenance and Fuel Costs (Mills per Kwhr)

	Costs for Entire Plant				
Month, 1939	*Operation (Inc. fuel)*	*Maintenance*	*Total*	*Fuel Costs Only, for Gas Engine*	*% Total Output by Gas Engine*
Aug.	4.06	.68	4.74	2.18	61.7
Sept.	4.24	.72	4.96	2.21	57.0
Oct.	3.88	.98	4.86	2.19	73.6
Nov.	4.28	.48	4.76	2.26	74.6
Dec.	4.70	.64	5.34	2.50	58.7
1940					
Jan.	2.23	2.08	4.31	2.43	39.0
Feb.	6.73	1.79	8.51	3.57	6.5
March	4.43	3.19	7.62	2.33	68.4
April	4.26	.76	5.02	2.40	56.1
May	4.26	1.07	5.33	2.33	61.3
June	3.41	.59	4.00	2.47	61.2
July	4.68	1.25	5.93	2.46	55.5
Average	4.22	1.09	5.31	2.35	58.8

Bituminous Coal Gets Pegged

After two previous acts came a cropper, Coal Act of 1937 finally is put into effect, setting minimum prices for bituminous coal. Here is a summary of what went before, what to expect and what the Act means to power engineers



▶ On October 1, after several years delay, the official schedules of minimum prices for every kind, quality and size of bituminous coal were put into effect, under the provisions of the Bituminous Coal Act of 1937.

To obtain an understanding of what has led up to the Bituminous Act and what is likely to follow, it is necessary to go back 20 years. Coal mining was greatly expanded during the first world war, and the subsequent readjustment has kept conditions depressed ever since. The surplus mines, miners and vast reserves of coal in this country have caused keen competition for the market and have held prices so low that many producers have been operating at a loss ever since the war.

Add to this the fact that the market for coal has lost business steadily in the past 20 years due to competing fuels and rising efficiency in coal use. For example, in this period iron and steel mills have reduced their blast-furnace consumption of coking coal per ton of pig iron by 20%. Utility power plants, using higher pressures and improved equipment, have lowered their consumption of coal per kwhr by almost 60%. In residential and commercial heating, improvements in boilers, stokers and heat-regulating devices have made serious inroads in the total amount of coal burned.

Other factors tending to make the coal producer's lot a hard one are relatively high labor costs prevailing since 1920 and increased taxation in recent years. Of course, under the pressure of shrinking markets, the industry has made tremendous strides in methods of mining and preparation. Use of machinery in these operations has greatly reduced the amount of hard manual labor involved, increased the productivity per worker, and helped coal producers offset in part factors working against them.

Thus, the industry has been following a fairly rocky road since 1920, and conditions have been begging somebody to come along and pave a nice smooth highway. In 1933, under the NRA, a Bituminous Coal Code was drawn up to maintain minimum prices and eliminate unfair competition practices, but this went by the boards when the NRA folded up in 1935.

This led to the Bituminous Coal Conservation Act of 1935 (often referred to as the First Guffey Act), which created a National Bituminous Coal Commission, prohibited the sale of coal below minimum prices approved by the commission and provided for penalties to enforce compliance. This act was declared unconstitutional in 1936.

A revised bill, known as the Bituminous Coal Act of 1937 (Second Guffey Act) was passed in April, 1937. Acting under this law, the Coal Commission ordered a schedule of minimum prices put into effect in December, 1937, but legal entanglements forced abandonment of the schedule in February, 1938. Then followed almost two years of exhaustive hearings conducted by the commission, at which producers, workers and consumers were allowed to speak their pieces. From these hearings, a new schedule of minimum prices was determined, which went into effect October 1, 1940.

Many Problems Involved

The magnitude of the problems involved in regulating prices and trade practices of the bituminous coal industry is staggering. The mere size of the industry is enough to tax the average man's imagination: bituminous coal is produced by more than 6500 active commercial mines, located in more than 30 different states, turning out 400,000,000 or more tons annually, and possessing reserves calculated sufficient to last hundreds of years.

There is wide variation in the size of coal mines, in qualities and occurrence of coal, in costs of production, in accounting methods, in transportation costs, in characters of markets, etc. After a tentative schedule of prices was drawn up, a final hearing was held which is described as "probably the most extensive administrative proceeding ever undertaken by any government agency". The transcript runs to 18,595 pages and almost 1200 exhibits.

It may be that the present Act will fall down just from the staggering load of factors it has to contend with. At any rate, consumers and producers alike have their fingers crossed as to whether the plan will prove workable, whether it will succeed in bringing lasting benefit to the industry, and whether the higher prices will seriously affect consumption. As to how the Act will affect power engineers, all that can be said at present is that somewhat higher coal prices will result, which will in turn provide a little more incentive to eliminate wastes in the generation and application of steam and electricity.

Power is indebted to the October business review of the National City Bank of New York for facts and figures used in this article.

New Power for Connecticut's Veterans

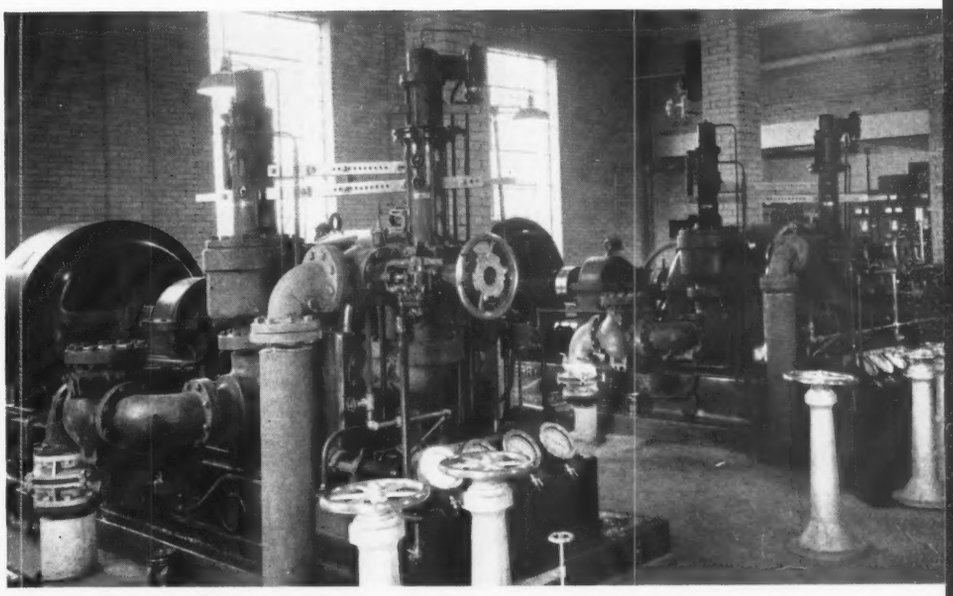
▶ CONNECTICUT'S brand-new home for veterans of Civil, Spanish-American and First World Wars, at Rocky Hill, just south of Hartford, was officially opened September 1. Designed to accommodate 1100 men, the four barrack wings now house about 500. Other fine buildings on the 320-acre plot of rolling ground include a large hospital, auditorium, administrative building and a big service building combining power plant, garage, laundry and maintenance workshops.

The central power plant heats all buildings with 5-lb steam, supplies both 5- and 50-lb steam to the kitchens and hospital (laundry steam at 85 lb), and generates all power requirements with two turbine-driven generators and one engine-driven unit. No steam goes to condensers and very little to atmosphere, so that electricity is almost entirely a by-product, with very low fuel cost.

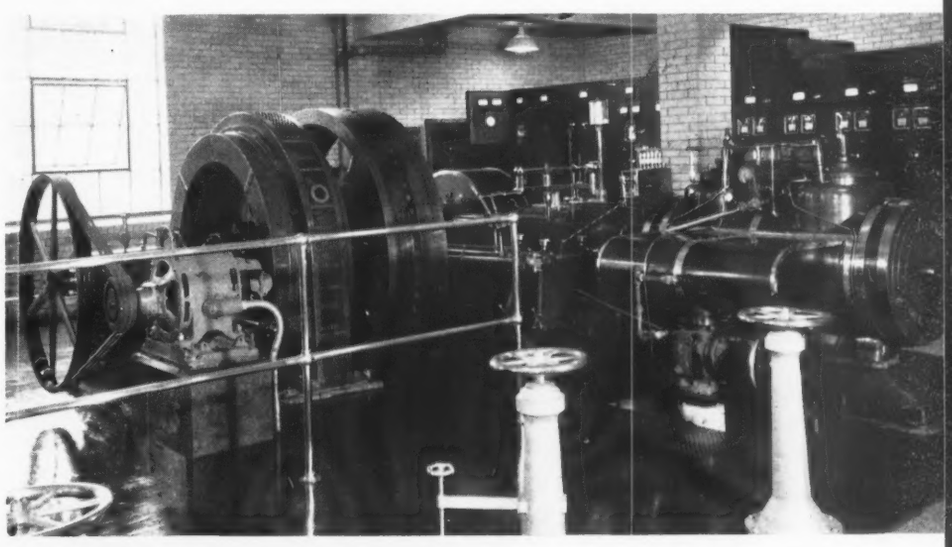
Steam is generated at 190 lb saturated in three stoker-fired boilers. Automatic reducing valves step this down to 50 and 5 lb to make up any deficit of bleed or exhaust steam. At present, night load is carried by the uniflow engine, day load by one turbine alone (other turbine is held for standby).

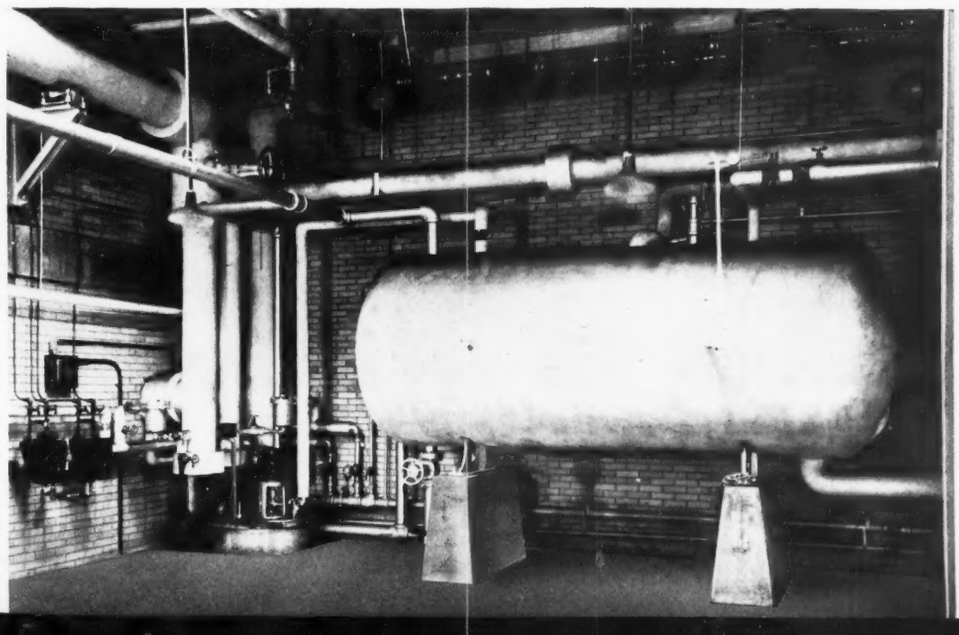
Architect of the project was Douglas Orr of New Haven, Conn. Henry B Van Zelm, consulting engineer, Hartford, designed the power plant. Photos were taken by POWER, with the cooperation of chief engineer J B Mathews.

(CONTINUED ON PAGE 98)



The two 335-hp Terry turbines, geared down 3795 to 1200 rpm, drive 250-kw Allis-Chalmers generators. Throttle steam is 190-lb saturated, backpressure 5 lb. Most of throttle steam is normally bled at 50 lb for kitchens and hospital process

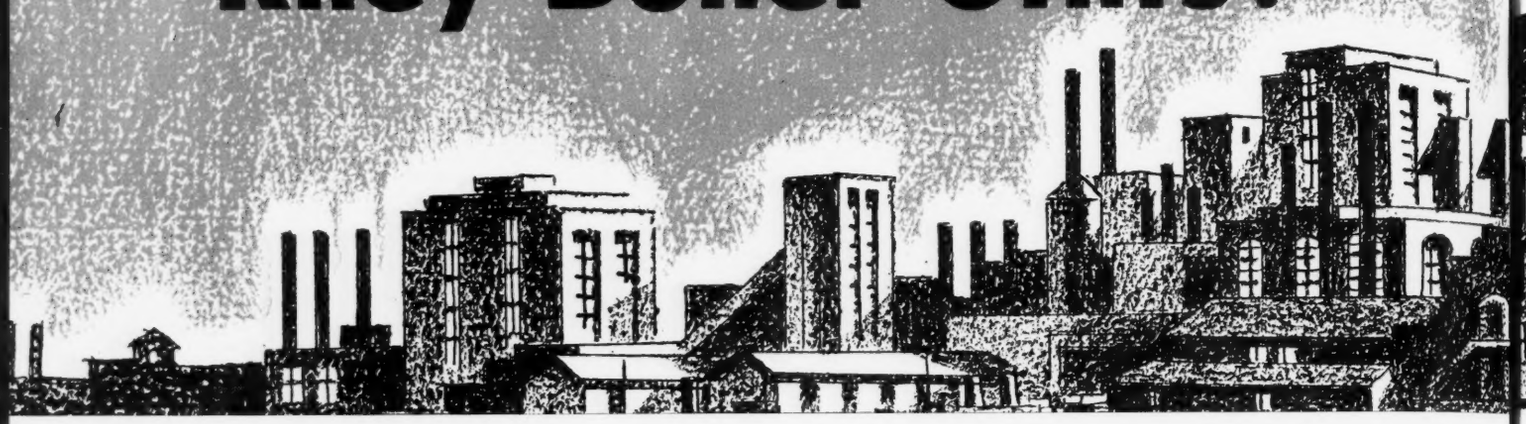




Skinner Universal Unaflow, 16 x 20 in., running 225 rpm, drives 150-kw Crocker-Wheeler generator. Note high-ratio V-belt drive of exciter. Engine expands steam from 190 to 5 lb. Both engine and turbine sets generate 3-phase, 60-cycle, 2300-volt current

Heating returns drain by gravity to sump (left). Sump pump delivers to returns tank

Who are purchasing Riley Boiler Units?



These leaders of Industry have

DOW CHEMICAL CO.
Freeport, Texas

UNION ELECTRIC CO. OF MISSOURI
St. Louis, Missouri

STANDARD OIL OF CALIFORNIA
Bahrein Islands, Persia

WORCESTER SALT COMPANY
Silver Springs, New York

U. S. GYPSUM CO.
Jersey City, New Jersey

CONSOLIDATED WATER POWER & PAPER CO.
Wisconsin Rapids, Wisconsin

PEPSI-COLA COMPANY
Long Island City, New York

SWIFT & COMPANY
S. St. Paul, Minnesota

HENRY DISSTON & SONS
Philadelphia, Pennsylvania

SCOVILL MFG. COMPANY
Waterbury, Connecticut

HOUSTON LIGHTING & POWER CO.
Houston, Texas

NUNN BUSH SHOE CO.
Milwaukee, Wisconsin

PET MILK COMPANY
7 plants

WINCHESTER REPEATING ARMS CO.
New Haven, Connecticut

CURTISS PROPELLOR CO.
Caldwell, New Jersey

GOODYEAR TIRE & RUBBER CO.
St. Mary's, Ohio

NORTON COMPANY
Worcester, Massachusetts

FLORIDA POWER & LIGHT CO.
Lauderdale, Florida

HUMBLE OIL & REFINING CO.
Baytown, Texas

BEECHNUT PACKING CO.
Canajoharie, New York

GOTHAM SILK HOSIERY CO.
Philadelphia, Pennsylvania

AMERICAN BRIDGE CO.
Trenton, New Jersey

MODINE MFG. CO.
Milwaukee, Wisconsin

MONSANTO CHEMICAL CO.
Nitro, West Virginia

These Consulting Engineers have

Stone & Webster Engineering Corp. — Sargent & Lundy — Ebasco Services — H. M. Wilson — Albert Kahn, Inc. — W. I. Barrows — Ford, Bacon & Davis — Ralph D. Thomas — Westcott & Mapes — Wiley & Wilson Burns & Roe — W. E. S. Dyer — Austin Company — C. C. Wilcox — F. P. Sheldon & Sons — Homan F. Hallock — Oscar A. Kisa — Stiles F. Kedy — J. B. Williams — Greenawalt Eng'ring Co. — R. Devere Hope

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recently installed Riley Boiler Units

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Wood River, Illinois

CARNEGIE-ILLINOIS STEEL CORP.
Rankin, Pennsylvania

CENTRAL ILLINOIS LIGHT CO.
Peoria, Illinois

NORTHERN PAPER MILLS
Green Bay, Wisconsin

AMERICAN VISCOSE CORP.
Nitro, West Virginia

WESTERN CARTRIDGE CO.
Alton, Illinois

GENERAL ANILINE WORKS
Grasselli, New Jersey

AMERICAN WATER WORKS & ELECTRIC CO.
Ashtabula, Ohio

CELANESE CORP. OF AMERICA
Narrows, Virginia

WESTINGHOUSE ELEC. & MFG. CO.
Lima, Ohio

MASONITE CORP.
Laurel, Mississippi

ALLIS CHALMERS MFG. CO.
Milwaukee, Wisconsin

ANDREW JERGENS CO.
Belleville, New Jersey

CROWN CORK & SEAL CO.
Baltimore, Maryland

REPUBLIC CREOSOTING CO.
Minneapolis, Minnesota

ST. CROIX PAPER CO.
Woodland, Maine

GENERAL MOTORS CORP.
Anderson, Indiana

CURTISS WRIGHT CORP.
Buffalo, New York

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Vermont Marble's Four-Station, Interconnected Hydro System

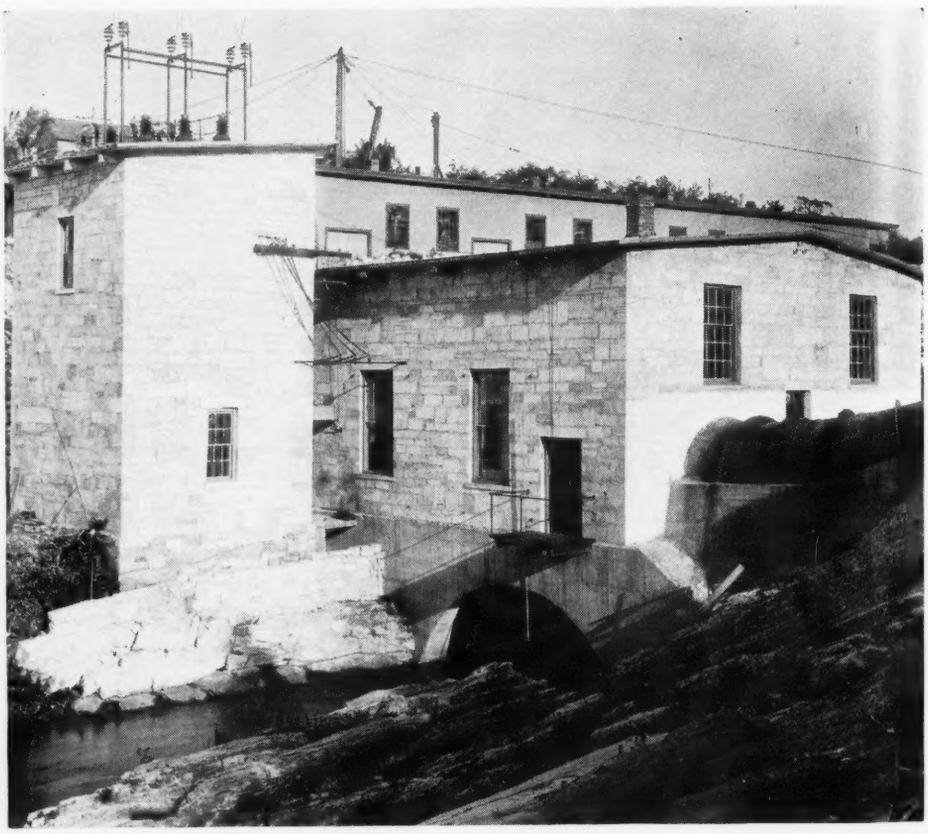
By FRANCIS A WESTBROOK
Consulting Engineer

▶ IT IS QUITE COMMON for public-utility companies to operate several water-power plants in parallel on the same river, but for an industrial concern to have such extensive power facilities is an exception. The Vermont Marble Co, such an exception, has a power system that includes four hydroelectric power generating plants and ten substations. These are all tied into a 44,000-volt, 80-mile-long transmission system serving the company's quarries and mills.

There are three main generating stations, the first of which (going upstream) is Huntington Falls with two 1200-hp units installed. Beldens has the same capacity as Huntington Falls; Proctor has one 2400-hp and three 1200-hp units. The Center Rutland plant with one 350-hp generating unit supplies power to the finishing mills there and is also tied into the main transmission system. At each industrial plant suitable transformer capacity steps down to 440 and 220 volts from line voltage.

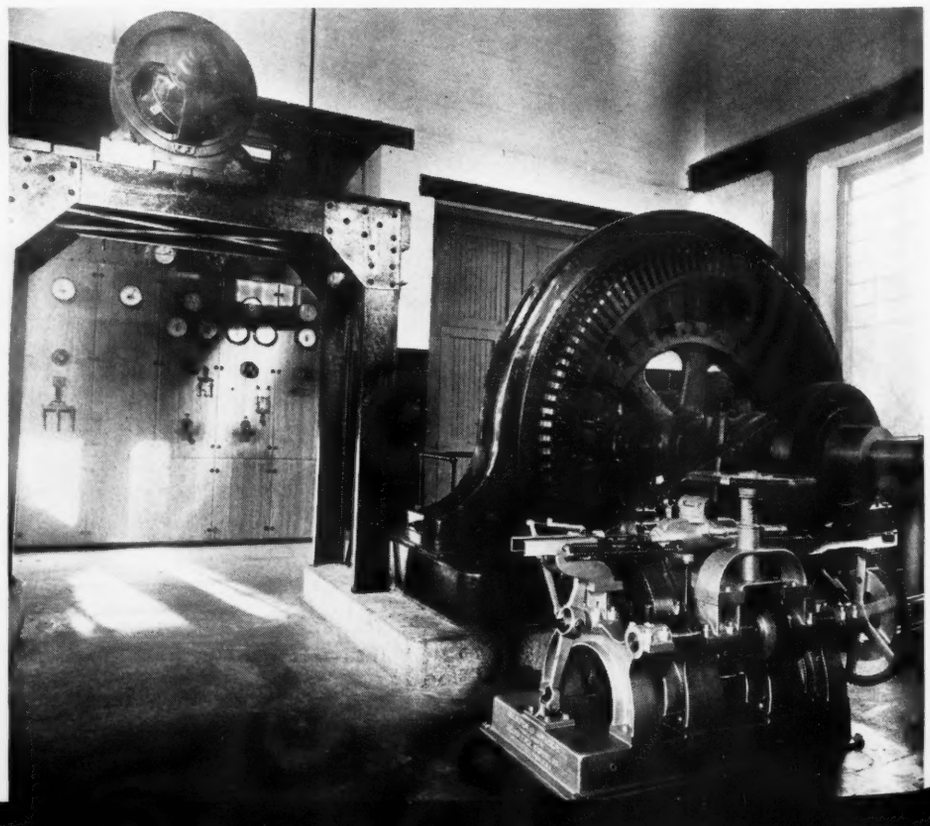
This power system is interconnected with Central Vermont Public Service Corp lines at Middlebury, Salisbury and West Rutland. Nearly 50% (between 10 and 15 million kwhr) of the annual power generated by the marble company is sold to the public utility. However, during low-water periods the marble company buys up to about 500,000 kwhr of power from the utility in a dry year.

As very little water storage is available at any of the stations, they operate as run-of-river plants. A large part of the water used at the generating stations comes from the Chitterden-dam reservoir back of Rutland. A load dispatcher at the Proctor shops supervises flow of water from the dam to maintain the head at the plants at the highest practicable level without wasting water over the dams. In this way, maximum power is produced from the available water. The dispatcher also controls putting into service or shutting down of units, loading the machines and switching on the transmission system.

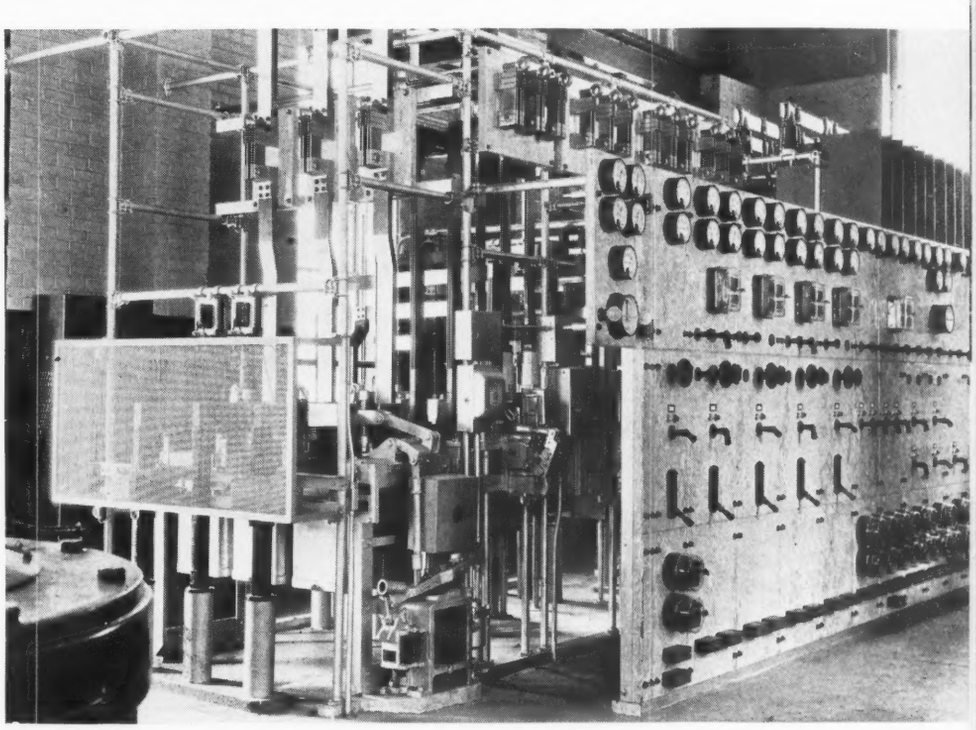


Beldens power station and penstock on the right, transformer substation on left

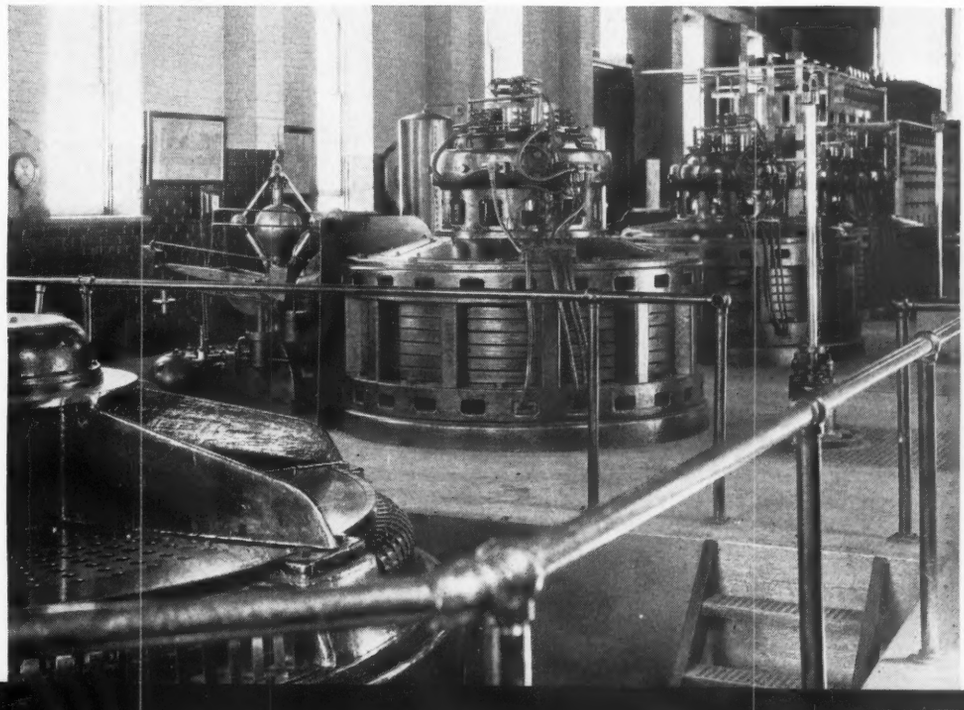
One of the two horizontal shaft 1200-hp units in Beldens plant. Governor for this unit shown in the foreground and switchboard in background



Huntington Falls dam and power house has two 1200-hp horizontal-shaft generating units and three 500-kva, 2300-to-44,000-volt transformers



Switchboard in Proctor power house. 480-volt generator bus structures and panels in foreground and 11,000-volt buses with control and meter panels in background



Proctor power house, the largest on the system, has one 2400-hp and three 1200-hp units installed operating at 480 volts

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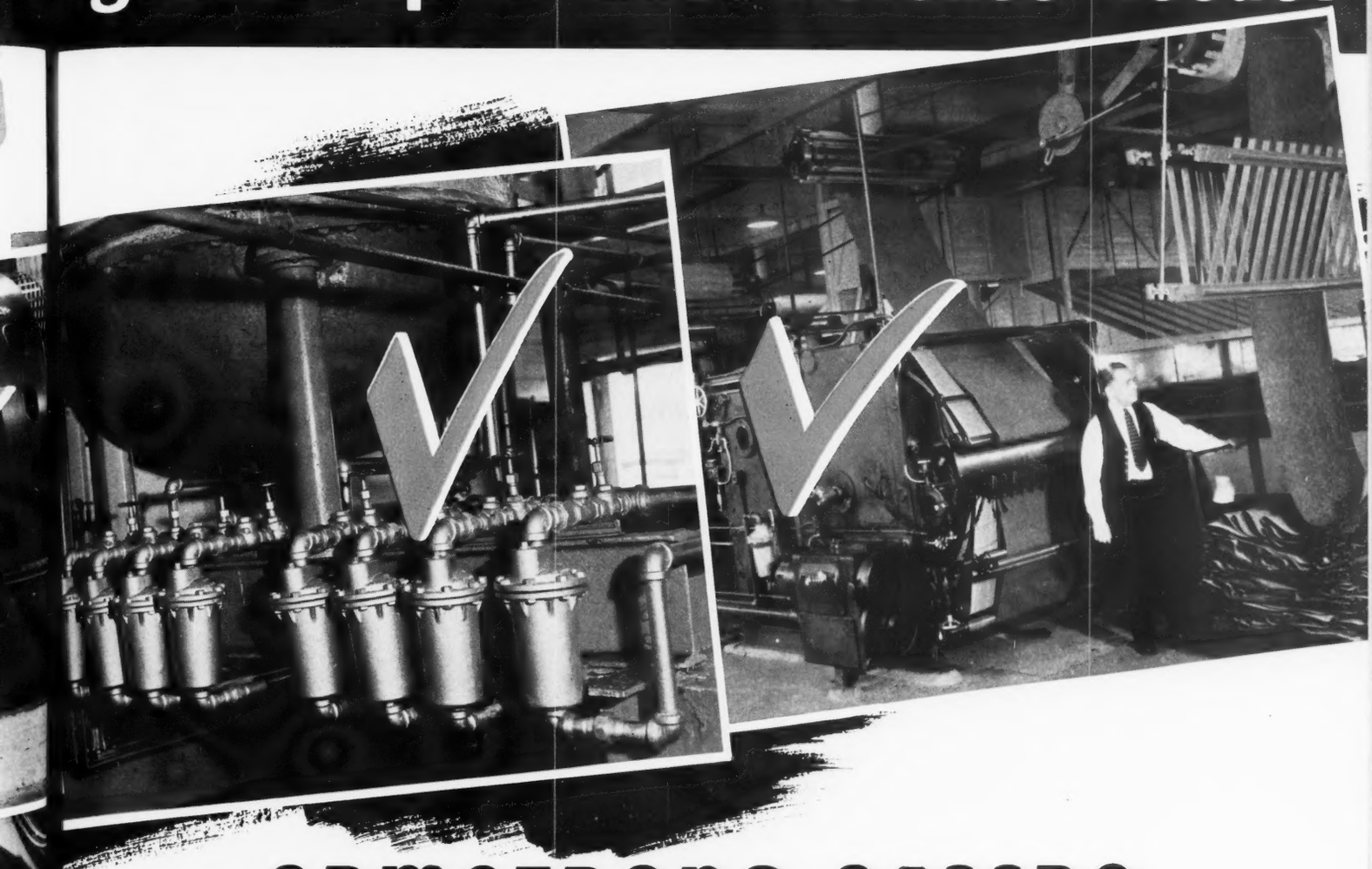

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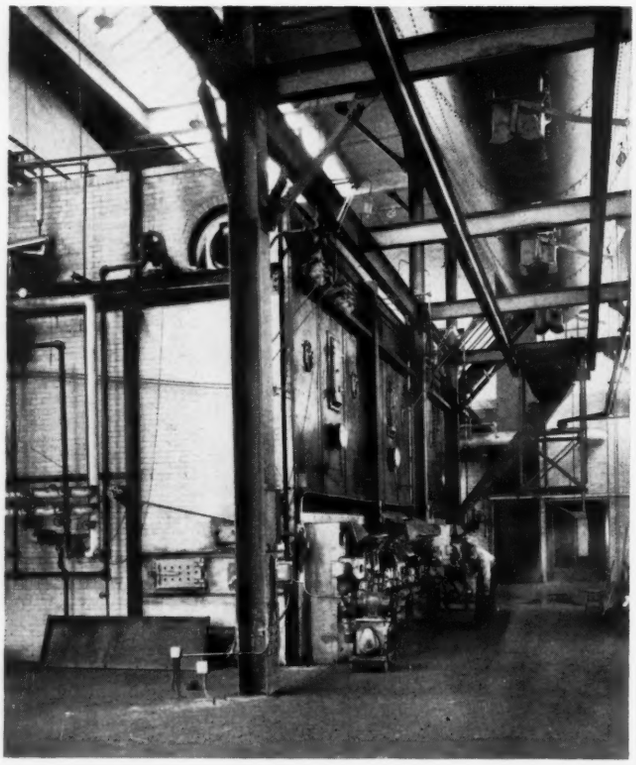
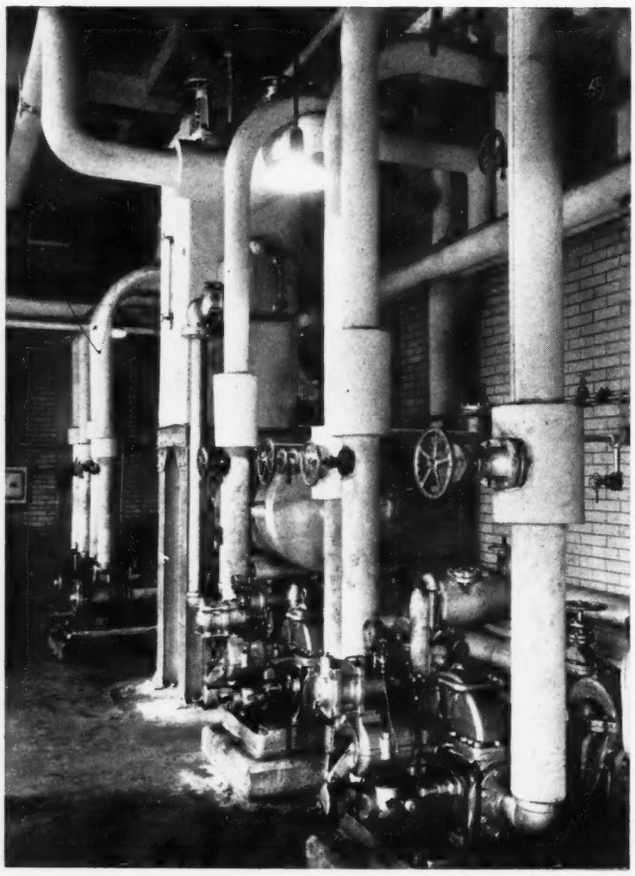
New Power for Connecticut's Veterans

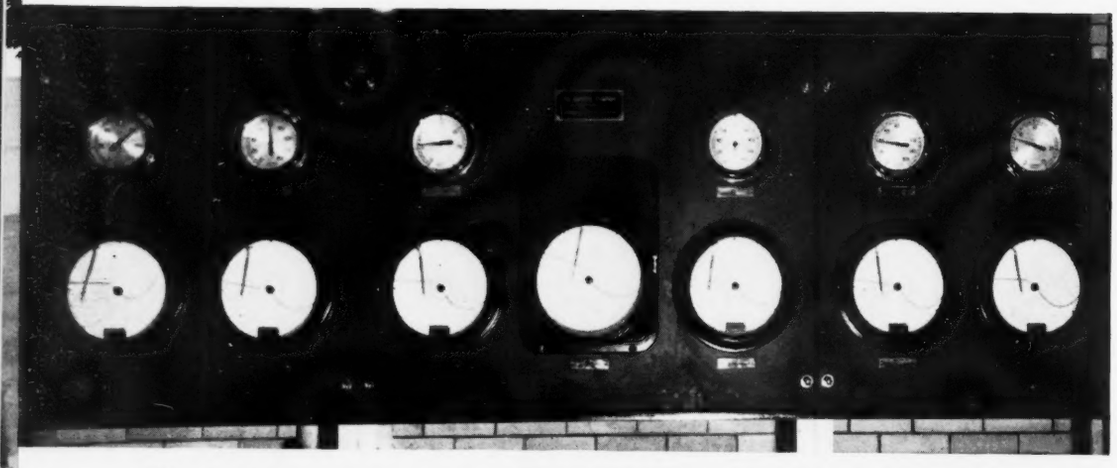
(Continued from page 91)



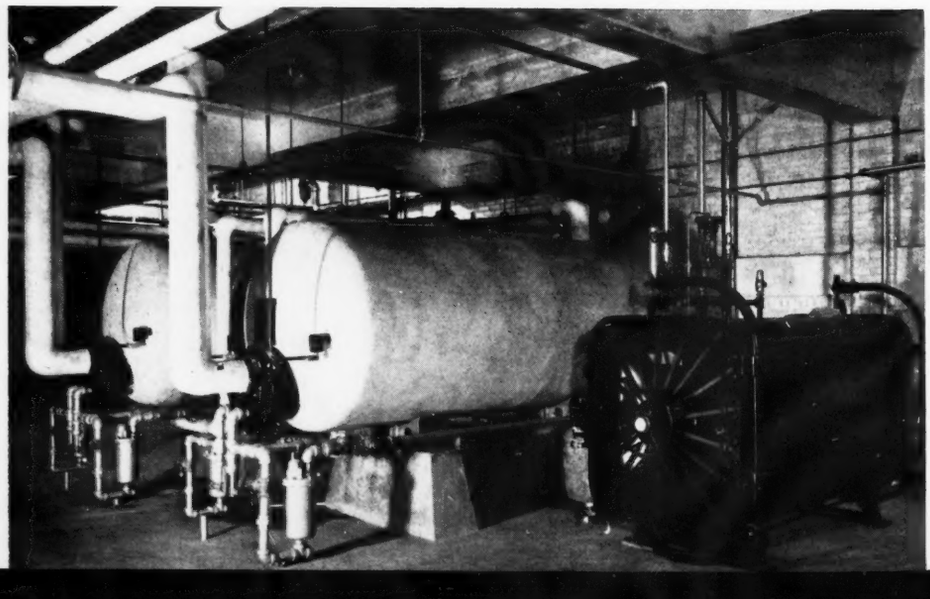
The three Bigelow, 3-drum boilers, fired by Perfection overfeed stokers, operate on natural draft. Coal is conveyed by belt and bucket elevator to overhead bunker, from there delivered by traveling weigh larry. A Bailey boiler meter serves each unit



In boiler pump room are two Worthington simplex feed pumps (left), two Worthington centrifugals (right) driven by Whiton turbines and two feedwater heaters (center)—an open heater above a closed. Plant can operate on either heater, fed with 5-lb steam



This Bristol pump-room instrument board (one of several in a well-metered plant such as this one) records feedwater-flow, pressures, temperatures, etc. Board in engine room measures throttle and bleed steam for each turbine



Next to pump room, in laundry basement, are these two laundry hot-water heaters normally operated on 5-lb steam, but automatically shifted to 50-lb in periods of high demand. Square steel box at right is steam-heated sterilizer

Hot Blast Gas for Dominion Steel

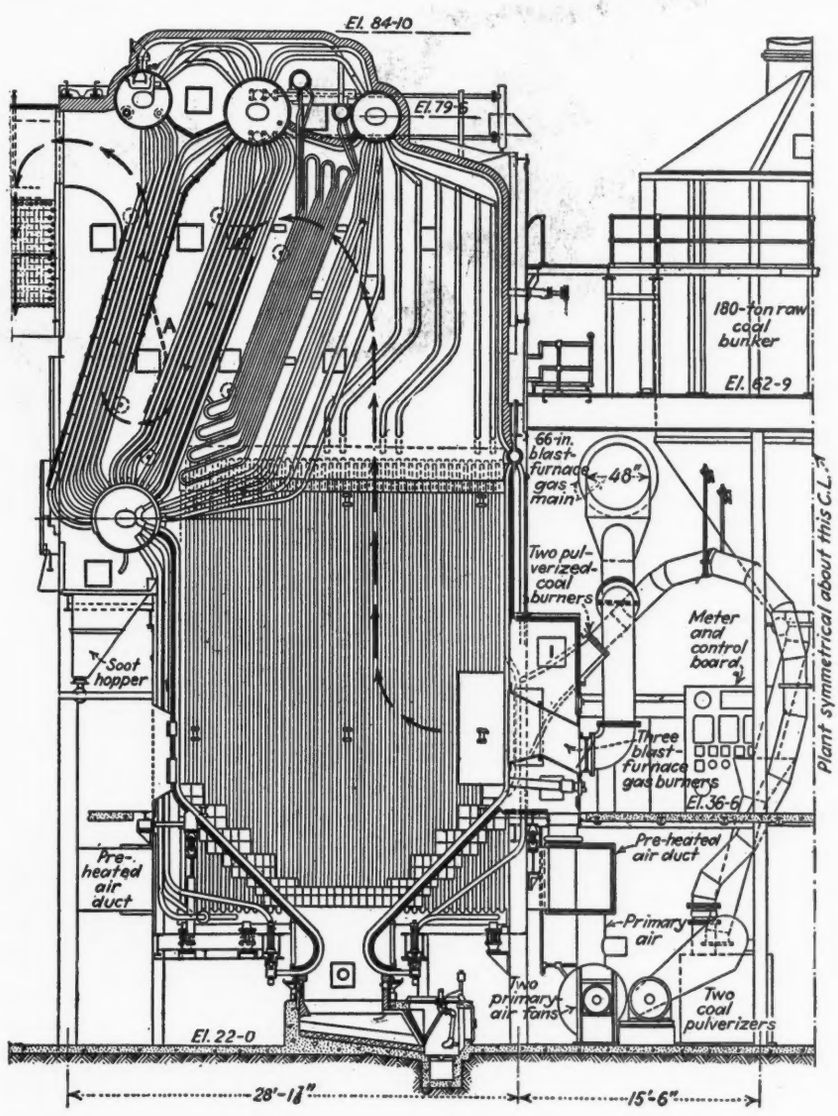
W S Wilson, chief engineer, reports installation of third boiler burning hot, dirty blast-furnace gas at Sydney, N.S., after three years' successful operation of two similar units

▶ So FEW STEEL MEN have had experience in burning raw blast-furnace gas that a report of three years' successful operation of two 450-lb steam-generating units with hot gas as principal fuel may well be placed in the record. The original installation, described in POWER, November, 1938, consists of two 4-drum Stirling boilers, each rated at 186,000 lb per hr, when burning pulverized coal and 165,000 lb per hr burning raw blast-furnace gas.

Gas enters the boiler at about 350 F. and of course is still "dirty". Dust needs to be removed from boiler surfaces about every two months when the draft loss becomes excessive, usually on a Sunday when the electric load is light. The dust is not caked and is easily knocked down. Some caking occurred at first, caused, we believe, by wet steam in the soot blowers. The calcined limestone evidently laid the foundation for a cement.

Tube blowing is still done by soot blowers using steam but we make sure the steam is dry. We also use a hand lance with compressed air. This procedure is now routine, and dust accumulations are history.

Original dust-catcher capacity of the blast furnaces was on the small side and an additional unit has been installed in the boiler-house gas main. This catcher traps and recovers about ten tons of coarse flue dust per day previously sluiced away in the ash-disposal system. The catcher can hardly be considered a gas "cleaner" in the accepted sense although it does knock out the coarser particles.



Combustion chamber is fully water cooled except for small patch of plastic chrome on the side walls near the gas burners

Erosion Corrected

In the beginning, some erosion of boiler tubes was caused by the position of one baffle. This was quickly corrected and we have found no further sign of erosion during the past 2½ years. Wear on the induced-draft-fan blades is quite normal and does not bother us.

Burning coal with about 10% ash and also "splint" with 20% ash in combination with blast-furnace gas does not seem to call for cleaning of the latter when the coal introduces more dust than the gas. Were we burning other fuels beside coal, that is, coke-oven gas, oil, or tar, we would clean the blast-furnace gas thoroughly. We feel that hot dirty gas is better than what we call semi-cleaned wet washed gas containing very fine dust that adheres closely to the tubes and walls.

Incidentally, we have not had an explosion in the boilers using hot gas during the three years of operation. When a blast furnace has "slipped", that is, the charge has become partly burned out and the remainder falls a few feet, the gas becomes heavily dust laden. At such times I have seen the boiler furnace go black, and yet when everything is cleared away, the gas is still burning.

In conclusion, we feel that the combination we now have is perfectly satisfactory and are now installing a third boiler of the same type and size to care for increasing loads due to steel-plant expansion.

Dust Laboratory Studies Fan-Abrasion

Practical research aimed at reducing fan-wheel wear develops vanes that not only control volume flow but separate out high proportion of flyash. Ingenious model-test arrangements are checked full size in field as well as laboratory, reports R L Lincoln, B F Sturtevant Co

▶ FAN WEAR THAT STARTS in a matter of weeks after the installation of large high-duty induced-draft units is, fortunately, restricted to a few localities that utilize high-ash coals. Wear from abrasion, however, is present to some extent in all induced-draft fans that have to handle cinder- or flyash-laden gas. In general, the rate of metal loss increases with greater static-pressure requirements involving necessarily high fan-wheel tip speeds and with high velocity of ash-laden gas across the face of the blade. Certain blade shapes are affected more than others.

The problem presented the fan manufacturer becomes somewhat different from the usual goodwill smoke and flyash elimination common in modern central stations. To avoid abrasion, the solids must be removed from the gas stream before the gas enters fan wheel, and, while high efficiency is desirable, elimination of three-quarters or more of the solids by a practical, not-too-costly collector is a first consideration.

The art of dust and cinder collection has progressed greatly since Mr Sturtevant built his first fans to overcome a dust nuisance in his own machinery in 1860. Fans and dust collection have been closely associated ever since; for example, the first combined dust collector and fan, known as the "Cindervane" fan, was developed by the Sturtevant Company in 1922.

Fig. 1—Effect of control-vane shape and position as separators for flyash can be quickly studied under glass while "caught and escaped" quantities are weighed to determine the relative collection efficiency

More Attention to Dust

Early dust-collecting fans, developed primarily for relatively large stoker cinder, are not considered efficient enough for the very fine flyash characteristic of all pulverized-fuel firing. Because the problem of fan abrasion fits in to a considerable extent with the general trend toward increased attention to dust elimination, an independent laboratory with a full-time organization has been devoted entirely to dust problems.

Such a modern dust laboratory has scientific equipment for analyzing all forms of dust, specific gravity, screen sizes, sub-screen sizes by air elutriation and other means, and visual analysis by microscopic measurement and the study of dust characteristics by photomicrographic means. In addition, facilities are available for storing and handling dust samples and weighing quantities from a millionth of a pound to several-thousand-pound quantities encountered in field testing.

Besides the laboratory facilities for analysis of dust, a complete test floor is available for testing complete dust-collecting apparatus under rigid laboratory-controlled conditions.

Field-testing equipment is another essential to insure that results obtained in the laboratory can be obtained in actual installations. Here, in addition to the newly perfected fan-type collector, are numerous cyclones, including the Buell Van-Tongeren, which are available for performance tests with different dusts.

This laboratory, housed in a 60 x 70-ft building, with a full-time staff of research engineers, has already proved its worth in testing dust-collecting apparatus of a wide range of types and sizes. In addition, it has provided the knowledge of collection efficiency necessary to the design and perfection of a dust collector that could be combined with a fan-inlet scroll to remove flyash *before* flue gas entered the fan wheel.

Other fan-type dust separators either collect solids after passing through the fan wheel or utilize only centrifugal action in causing the separation. This design covered use of the momentum of the dust particles during an abrupt change in direction of gas flow as well as centrifugal action.

Small models, Fig. 1, representing a segmented section across a collector, are cut from a heavy rubber sheet and mounted under glass to permit a visual study of the dust while the model is operating. Air is drawn through the segment in the same manner as through a large scale model. Many more variations of scroll shapes and vane designs

Problem

can be thoroughly tested than would be practical with 3-dimensional model construction. From these investigations, a number of experimental test units were made and tested. Later, large-size units were built and tested under actual field conditions. These latter have been in successful operation for several years.

Two large fans, incorporating the volume control and dust-separating vanes, Fig. 3, were installed in a large central station. Operation has been reported so successful that a repeat installation of even larger size has been ordered by the same engineers, Fig. 4, to handle 170,000 cfm at 385 F, 17.7 in. static pressure. The latter fans have an improved collector device derived from laboratory study and are expected to have better efficiency of collection.

Briefly, the collection system consists of a spiral inlet box as part of a standard induced-draft fan. Gas and dust entering the inlet box are acted upon by centrifugal force, the solids tending toward the periphery. By the addition of special vanes mounted in the box, the gas is given a sudden reversal before entering the wheel. The combination of the two effects produces an unusually high separation, even of fine flyash. The concentrated dust is removed from the spiral inlet box through a shave-off spout, clearly indicated in Fig. 4, from which it is drawn through an auxiliary cyclone. A small auxiliary fan returns the gas to the system. Dust is retained in a storage hopper at the base of the cyclone.

Much additional field test data will be required before full knowledge of the possibilities of this dust-collecting system can be published. In the meantime, laboratory investigation of the abrasive qualities of various types of flyash is continuing and further development of the apparatus can be expected.

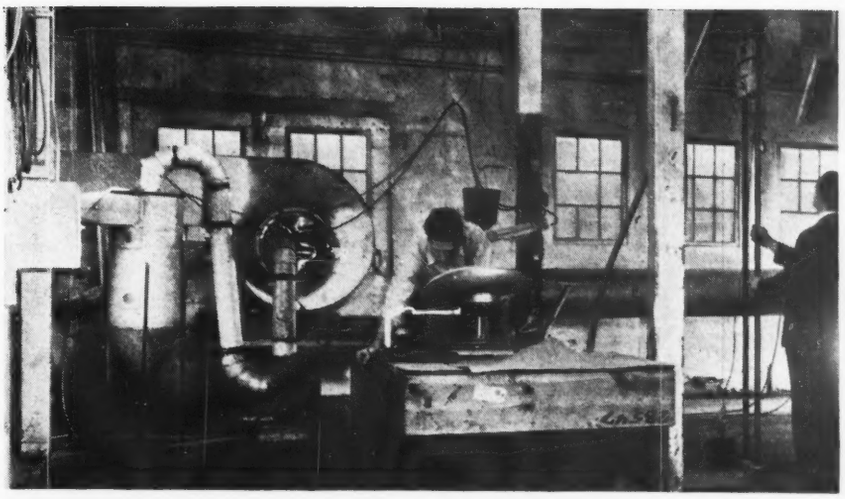


Fig. 2—Next step is check on model test by building an actual fan. Weighed quantities of several types of flyash establish confidence in test procedure

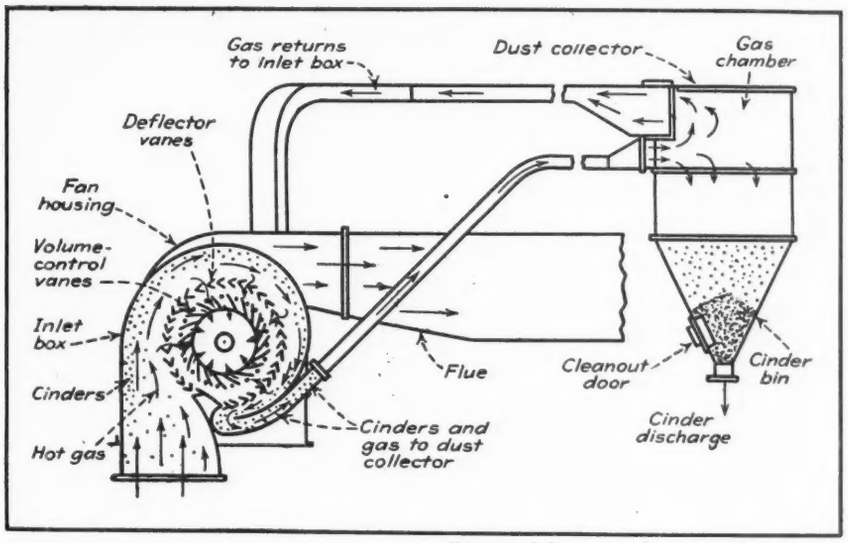


Fig. 3—Schematic drawing of fan with separate dust-separating and volume-control vanes showing scroll arrangement and cyclone collector

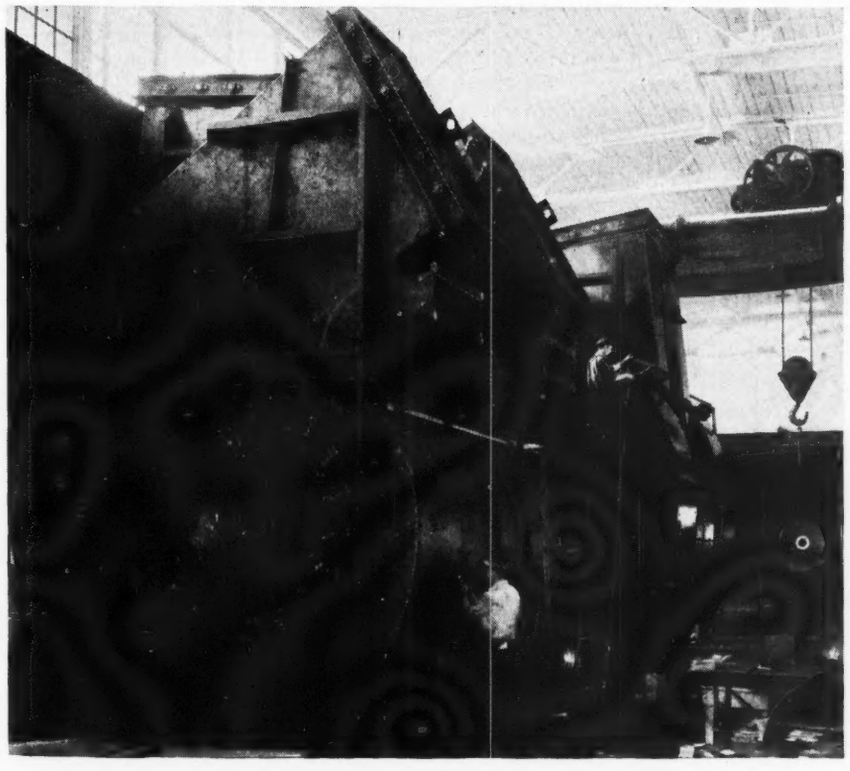


Fig. 4—Shop view of flyash collecting fans that will handle 170,000 cfm at 365 F and 17.7 in. static pressure

Speaking of Power

"Today's power engineer gets his facts from meters and executes his decisions through controls." There's an idea in this caption of our front-cover photograph of the man at the board. The power engineer in the modern plant is a "middle man." He gets his information from one set of gadgets and uses other gadgets to put his decisions into practical effect. . . . He looks to ammeters, temperature recorders, CO_2 meters, or pressure gages for his facts. Then he uses his judgment and experience to decide what must be done. Finally, he presses the right button or turns a dial to the correct point. . . . In some plants, the meters "talk" directly to the controls, which will act intelligently even if the engineer is looking out the window. Such automatic controls might seem

The power engineer is a middle man

to make the engineer's intelligence unnecessary. Actually, the installation of automatic controls requires the application of intelligence in the first case, and, secondly, frees the engineer's mind from detailed decisions for the general problems of plant management. . . . Instead of watching gages all day, he can think about what gages he needs and how their readings should determine operation.

Associate Editor Stan Tucker, just back from Milwaukee, tells me to expect interesting developments concerning the gas turbine. Dr J T Rettaliata, Allis-Chalmers research shark and gas-turbine expert, passed on the tip that metal-creep tests now in progress show possibilities of

Metal-creep tests show possibilities

permitting use of gas temperatures 200 degrees or more above present limits. . . . This, of course, is a step in getting the gas turbine from a highly specialized oil-refinery auxiliary to a commercial power-generating unit.

I haven't been making any grand tours recently, but two "local circuits" come to mind. Skirting Boston, when that city was pretty well bogged down (or buoyed up) with the Legion Convention, I had a fine session at Peter Starratt's power plant, New England Confectionery Co. "Necco" is the biggest candy factory I have ever visited. A year or so ago we published some very practical kinks from the Starratt plant. In another month I hope to give you the story of his new centrifugal refrigerating unit driven by a backpressure bleeder turbine, and a little later, something rather new in boiler operation.

Skirting Boston

During the first week in October I spent a couple of days in Cleveland, Ohio. First on the program was an all-day session at Nela Park with a lot of other editors. In case you don't know what Nela Park is, I should explain that it is the beautifully landscaped and park-like national headquarters of all the electric-lighting research of the General Electric Co. . . . The extent of the Nela Park operations is impressive. Results, measured in lighting kilowatts the American public didn't have to pay for, have been staggering. The aggregate saving represented by the increase in efficiency from the carbon lamp to the tungsten to the gas-filled, and now to fluorescent, is measured in hundreds of millions of dollars. Yet lamps are very cheap, because they are made by mass-production methods, and because the cost of research which has perfected them is spread over millions of items.

At Lincoln Electric Co, I told my friend A F Davis that I was fed up on just reading and writing about welding. A F, a man of action, dug up a pair of overalls to cover my business suit and had me pushing an arc for three hours out in his welding school. He

Editor pushes an arc

hasn't hired me yet; I'm not good enough. I will say, though, that it's in my blood and that I hope to tackle those electrodes again for a longer session next time I'm in Cleveland. Last time I worked at it just long enough to convince myself that welding is something that must be learned by doing.

From the calendar of coming events, I note that the first week in December will bring many power engineers to New York to attend the Power Show and the annual meeting of the American Society of Mechanical Engineers. Elsewhere in this issue (page 122) will be found programs and descriptions of these two important functions; in this corner it's enough to say that we (the POWER staff) always look forward to seeing many old friends and making new acquaintances at this biannual engineering roundup. We say this in spite of the fact that we end up the week pretty well run ragged with trying to be several places at once. Incidentally, accept this as an invitation to come up and see us at 330 West 42nd St (29th floor)—the latchstring is always off.—PWS

THE OPERATING ENGINEER

George Edwards
Advisory Editor

Practical Aids
Maintenance Hints
Questions — Answers

Published monthly as an integral part of POWER

MORE YANKEE INGENUITY
at R Wallace & Sons Mfg Co

Plant improvement is part of the everyday job at the Wallingford factory of silversmiths—here's a roundup of "changes for the better" made during last year

JOHN MATSON, chief engineer at R Wallace & Sons Mfg Co, famous silversmiths of Wallingford, Conn., believes that the power plant doesn't exist that can't be made better. Day-by-day improvement in equipment and methods of operation comes pretty close to being his religion and he practices what he preaches. Back in October, 1939, we told of a series of major changes in his plant which produced husky savings, and in November of the same year we ran a series of pictures of some of his "Yankee contrivances" designed to make operation better, safer, and easier. When an editor dropped into the Wallace plant a short time ago, while visiting New England subscribers, he found that the past year had been put to good use in dozens of little ways. The plant looked just the same, but the records showed that "changes for the better" cut operating costs again, while service was even more satisfactory. The first 39 weeks of 1940 show a saving of almost 10% over the same period in 1939 and 80% over 1935.

Fig. 1—Permanent set-up simplifies gaging fuel oil—another measuring device will go on the new 315,000-gal. oil tank in the background

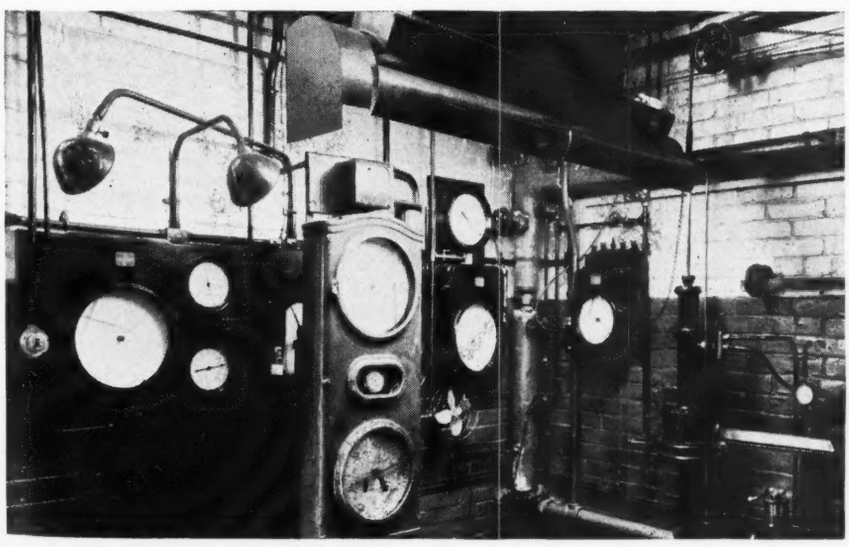


Fig. 2—New fluorescent lighting unit puts cool, high-intensity light where needed—at boiler-room "headquarters"

A big steam-saver, and an improvement that made everybody happy, was the dividing of the plant heating system into five zones. Originally, one system, supplied with exhaust and bled steam, served the widespread and numerous factory buildings and the office and gatehouse. Boosters, mentioned in the previous articles, helped maintain satisfactory conditions in the hard-to-heat buildings, but it was practically impossible to keep a uniform temperature in the plant and steam was being wasted. Last summer,

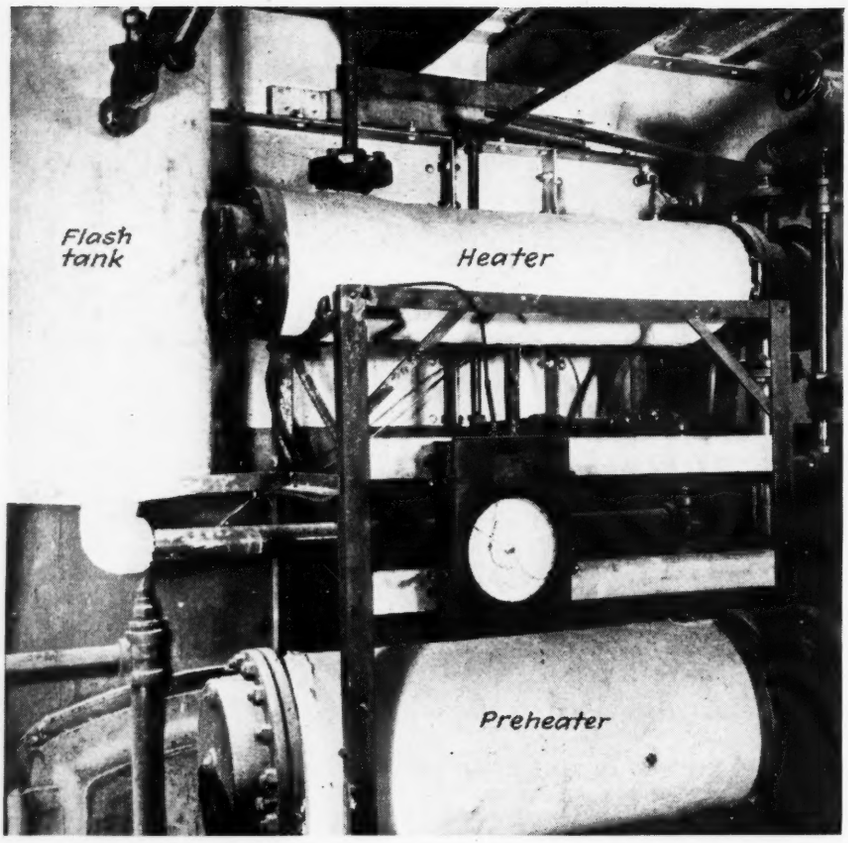


Fig. 3—In tank (upper left) part of condensate from fuel-oil heater flashes to steam and enters heater while remaining condensate goes to preheater; make-up water flows through lower heater, then upper, picking up waste heat

the plant crew made the necessary piping changes and added enough reducing valves to break the single system into 5 zones, giving much closer control. Experience proved the benefits of the change.

Last winter's difficulties with fuel-oil delivery convinced everybody at Wallingford that more storage capacity was necessary—the result, a new 315,000-gal tank outside the power plant, just back of the old one. This insures a 7-week supply, enough to tide over any shortage or delay in deliveries. While extending the oil-handling system, John Matson decided to simplify the business of gaging the tanks, Fig. 1. The smaller, older tank was equipped with a pipe running down to within a few inches of the bottom and fitted with a cap on the end projecting from the top of the tank. After the fashion of the crankcase gage on your car, the pipe carries a permanent measuring stick formed by tackwelding two $\frac{1}{2}$x$\frac{1}{8}$-in. steel strips to form a "T". The stick is calibrated to show much oil can be added to the tank; this helps guide transferring oil from the new large tank to keep the smaller tank filled. The new tank will be equipped with a similar measuring tube but instead of a stick, measurements will be taken by means of a steel tape fitted with a streamlined plumb bob.

Numerous small changes make the boiler room more efficient and a better place to work in, as, for example, the new 48-in., 2-tube fluorescent-lighting unit in the instrument corner. The even high-level illumination resulting can be judged from the fact that the photo (Fig. 2) was taken without any other lighting and with an exposure of only a few seconds. Other boiler-room improvements include an electric-eye smoke alarm to supplement the mirror system previously described, thermostatic control on oil supply to the burners, and boiler sidewall insulation. This latter job utilized old magnesia covering: a layer of insulating cement was first applied, then three layers of broken-up magnesia pipe covering (scrap) soaked in water. On top of the smoothed final layer of magnesia went a thin layer of asbestos cement, smoothed to a good finish.

Btu Saver

The photo (Fig. 3) shows another Btu-chaser added during the past year. In this small flash tank and heaters, condensate discharged from the fuel-oil heaters and continuous blowdown water discharged through a seal at 3 lb give up precious heat units to make-up water. Water flows through the preheater (below) first, then the heater (above); steam from the flash tank goes to the heater and condensate goes to the preheater. This setup would be more trouble than it's worth, even with heavy winter demand for exhaust steam, if it were not for another "Yankee contrivance" designed to keep it free of blowdown sludge. Similar arrangements keep other heating surfaces clean also, as described below.

Water from the Quinnipiac River, used for cooling and for makeup, runs high in dirt and foreign matter of all kinds and so presents a cleaning problem. Fig. 4 is a closeup of a scheme for "nudging" the dirt from heating surfaces by compressed air. The 30-lb air line (circled) tapped into the inlet pipe of one of the main condensers permits effective cleaning without shutdown; occasional slugs of water and air do the trick. This arrangement doubled the allowable time between tube pluggings. Similar connections have been fitted to the generator air coolers, turbine oil coolers, the ejector condenser, and the heat exchangers shown in Fig. 3.

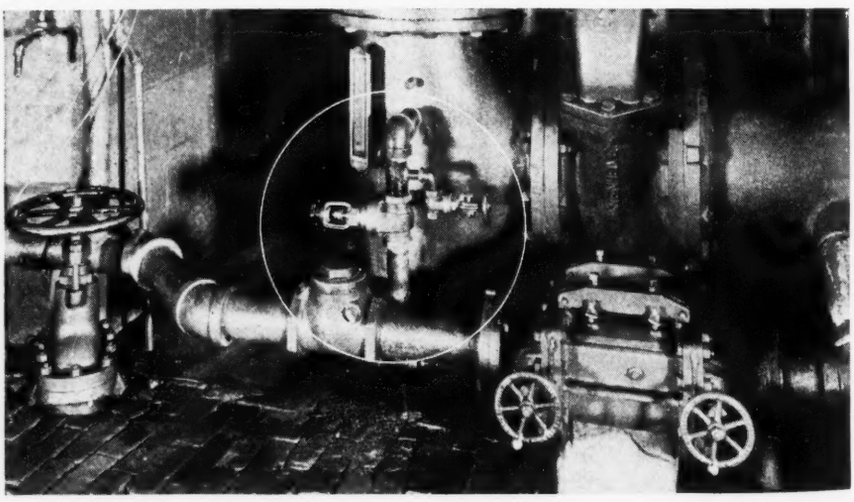


Fig. 4—Compressed-air connection (30 lb) at condenser inlet permits "nudging" dirt from tubes with occasional slug of air and water

Small Lathe Saves Big Expense
ON TURBINE-GENERATOR REPAIR

By N D JACKSON
South Bend Lathe Works

▶ INGENUITY is not a trait peculiar to Yankee country alone, but blossoms in such far-away places as Hawaii. Out there on the island of fish and poi, the electric utility company had trouble with the bearings of a 12,500-kva steam turbine-generator. Bearing surfaces on both ends of the shaft were badly scored and had to be remachined.

Operators discarded the idea of removing the 22-ton shaft assembly and taking it to a machine shop because of the time and money involved. Work was further complicated by the fact that there was no lathe in any nearby shop large enough to swing the shaft and 8-ft diameter turbine wheels.

Special Tool

The engineer in charge of the job showed his skill and resourcefulness by using a small bench lathe to remachine the journals without removing the shaft assembly from the turbine. He took off the turbine bearing caps and bolted the bed and carriage of a 9-in. swing lathe to the turbine frame. The lathe-bed vee-ways were carefully aligned with the shaft. A special goose-neck cutting tool, Fig. 1, forged to suit the job, was mounted in the tool post of the lathe.

An old hoisting rig driven by a 5-hp motor was set up on the floor and geared to the turbine in such a way that it would drive the shaft at a suitable speed. After starting the turbine shaft, the forged cutting tool was fed along the scored journal surface by turning the lathe carriage handwheel. A smooth finish was obtained and a first-class job turned out in short order at low cost.

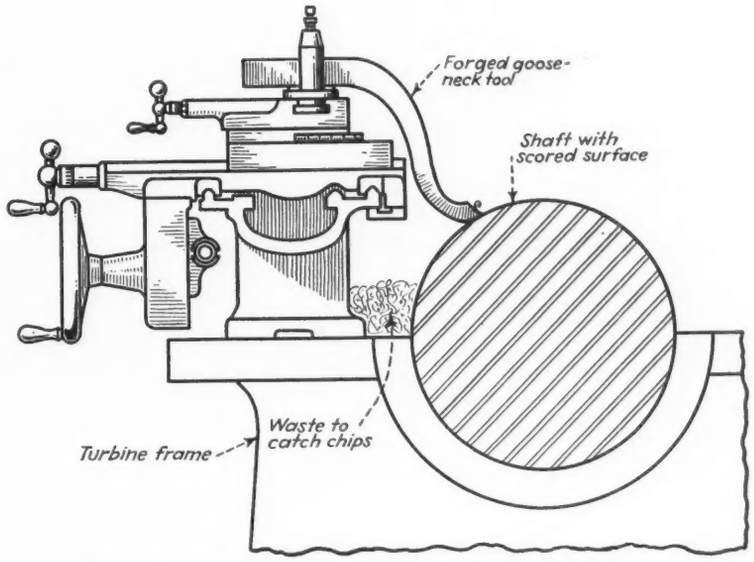


Fig. 1—Forged goose-neck tool trues journal surface as shaft turns in bearings

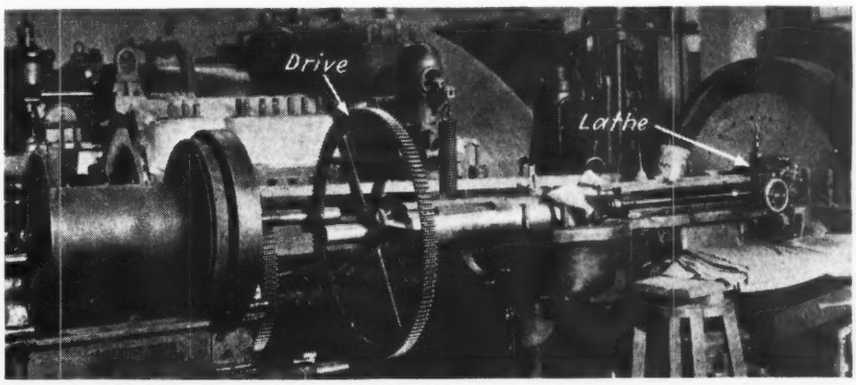


Fig. 2—Hoisting engine driven by 5-hp motor geared to drive turbine shaft

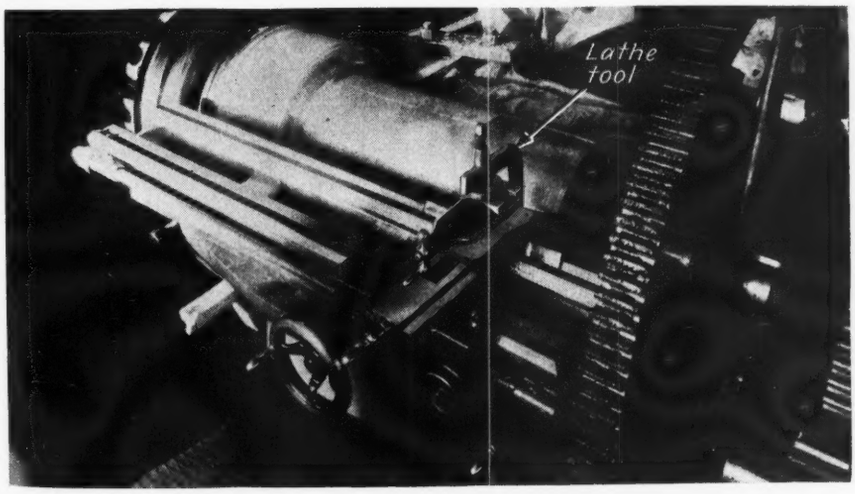


Fig. 3—Forged cutting tool in tool post of 9-in. lathe mounted on turbine-bearing frame for machining scored shaft journal

POLLUTION HAZARDS
in Your Building's Plumbing?

Most states and large cities have laws safeguarding water-supply systems, but cross-connections and back-siphoning still threaten health in many public and private buildings. John Herzog, chief engineer of St Mary's Hospital, San Francisco, gives practical pointers on where to look for pollution trouble and how to cure it

▶ SUPPLY AND MAINTENANCE of unpolluted water systems has always formed an important part of the engineer's job. Water supplied by public utilities can be considered perfectly safe and suitable for drinking in most cases, and water from wells or other private supplies can be checked by means of simple tests. However, engineers sometimes lose sight of the fact that pure water entering a building may become unfit for human consumption through faulty piping connections or obsolete plumbing fixtures.

The subject of water pollution was considered in this country as early as 1894, and much earlier in Europe, but it was not until several disastrous epidemics, especially an outbreak of amoebic dysentery during Chicago's 1933 World's Fair, were traced to faulty piping connections, that definite steps were taken to prevent water pollution.

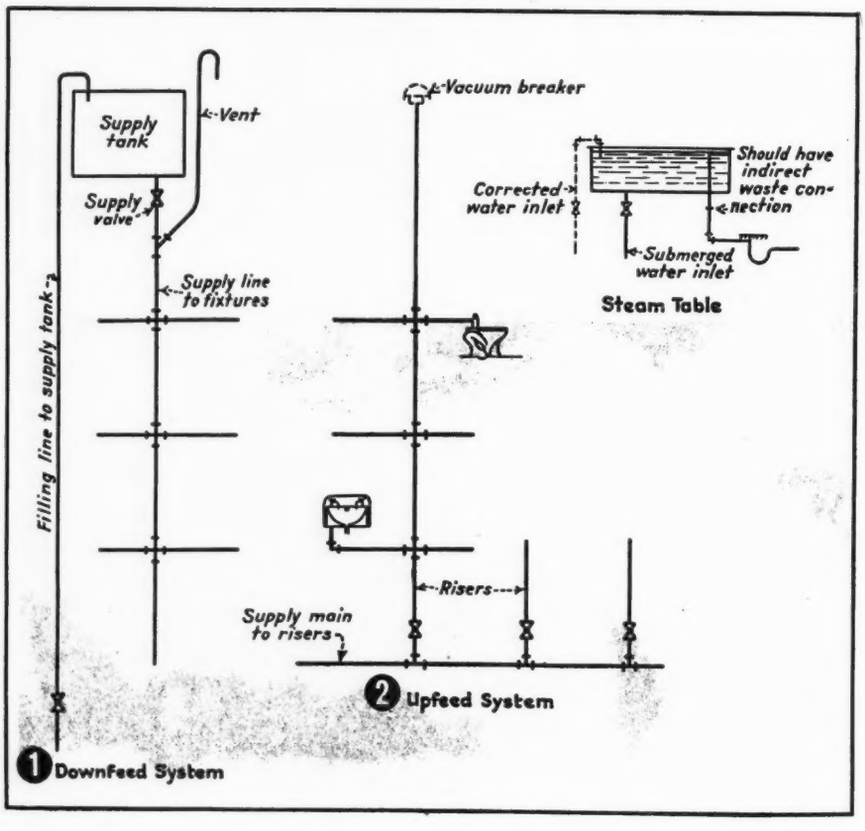
Laws and Regulations

During the last 5 years, most states and larger cities have enacted laws and regulations to safeguard water-supply systems, but it is still likely that competent tests in public and private buildings, such as schools, hotels, hospitals, and offices, would show water-pollution hazards in many of the plumbing systems. Buildings are still erected in which supply lines are not half large enough, cross-connections exist, and unsafe plumbing fixtures invite back-siphoning.

Not long ago, an institution built a $225,000 addition. The chief engineer for the owner recommended concealed vacuum breakers on all risers, and flush valves with built-in vacuum protection. The architect in charge of construction couldn't see the need for spending the large sum of $95 for these safety measures, as long as there was no law compelling him to do so. Six months after completion of the building, the city enacted an ordinance regulating cross connections and after tests showed back-siphonage was possible in this building, vacuum breakers had to be installed at a cost many times in excess of the original $95.

Recently I visited one of the largest public institutions in a city which has had an ordinance regulating cross-connections for the past 5 years. Expecting to see the latest in sanitary plumbing and connections conforming to the required standards, I was surprised and shocked to find obsolete fixtures and hazardous cross-connections, especially in the isolation department for contagious diseases. "Don't do as I do, do as I say" was only too true in this case. While back-siphonage in water-supply systems admittedly depends on the occurrence of certain abnormal conditions, public health and well-being should not be left to chance, and everyone concerned should do their utmost to prevent spreading of disease.

What constitutes a pollution hazard?



Basically, any connection, direct or indirect, which will permit flow of contaminated water into a drinking water supply, under certain conditions of flow or pressure. Direct connections are generally found between two independent water-supply systems, say a utility supply for drinking water and a well system for general purposes. As connections of this kind are usually easily accessible and proper installation and operation can be readily checked by inspection, risk of flow in the wrong direction is not as great as in the case of indirect connections.

An indirect cross connection exists when a water-supply line, not physically connected to any other line or vessel, may be subject to backflow under certain special conditions. For example, in any basin, bathtub, water-closet or tank where the water inlet may become submerged or where water level may rise too close to the inlet, backflow may occur, due to a siphoning action, if pressure in the supply line drops below atmospheric. This might follow the closing of a valve in the line, a line break, or failure of an inadequate supply line to take care of the demand.

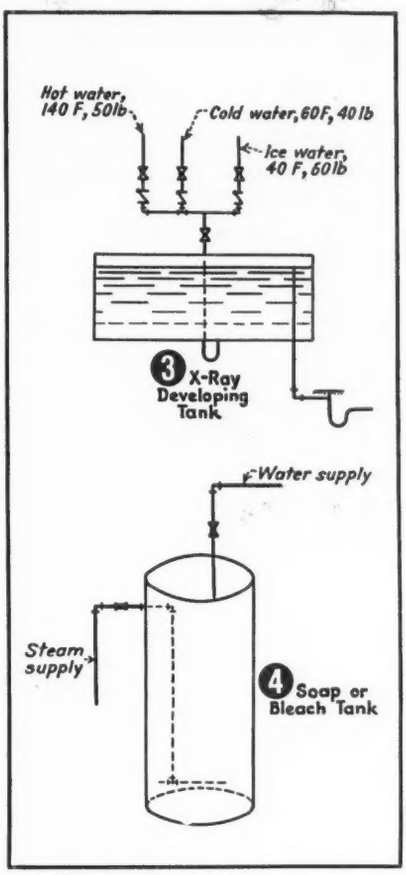
Methods of Distribution

To some extent, the chances of back-siphonage depend on the method of distribution: these are the upfeed system, in which the lines connect directly to the service main, the downfeed system which receives its supply from an overhead tank, and the pressure-tank system using either a pump or compressed air and arranged for either upfeed or downfeed distribution. As the downfeed system generally vents to the atmosphere, (1), back siphonage is not as common as in the other two systems.

The layout for an upfeed system is shown in (2), which also shows how the connections for a steam table can be corrected to avoid backflow possibilities. Whenever the various risers or feeders run in straight lines and branches are neither too long or too many, one vacuum breaker at the top of every riser will be sufficient. However, the breaker should be the same size or even larger than the supply line. This method makes savings when back siphonage must be eliminated in an existing system.

To test an upfeed system for backflow, pour some colored vegetable dye into the top plumbing fixture after filling it to the rim. Close the valve on that particular riser and open one of the valves on a lower fixture. Some of the water in the line will flow out, creating a vacuum which will, in turn, draw the contents from the upper fixture through the pipeline, when the valve is opened. Eventually colored water can be drawn from any faucet.

In general, there are four ways to prevent back siphonage in a water-supply system: (1) install vacuum breakers, (2) extend risers through to roof and vent them to atmosphere, (3) insure safe air gaps between fixture water level and water inlet, and (4) install check valves. Vacuum breakers on various fixtures or risers represent an approved solution in many cases (see sketch 2), but may prove expensive. Some of the newer flush valves and toilet bowls have built-in vacuum breakers.


Hot water, 140 F, 50lb
Cold water, 60F, 40 lb
Ice water, 40 F, 60lb
3 X-Ray Developing Tank
Water supply
Steam supply
4 Soap or Bleach Tank

Various formulas have been worked out to determine the proper distance between the water level in a fixture and the water inlet. It is generally agreed that the air gap should be at least 1.8 times the diameter of the water-inlet opening. Tests have shown that water can be drawn over a 2-in. air gap by a 28-in. vacuum in a 2-in. pipe.

Although check valves are commonly used, they cannot be depended on, alone, to give positive protection against back siphoning. Sketch 3 shows an X-ray developing tank. The three supply lines have different pressures: 60, 50, and 40 lb. It is possible with leaky check valves to run ice water at 40 F into hot water at 140 F or cold water at 60 F, or any other combination. Even more important, it is possible to siphon the acid-polluted water into the system whenever the inlet is submerged.

The last sketch, 4, shows a soap or a bleach tank in a laundry. With the water inlet submerged or the water level too near the inlet it is possible to draw the soap or bleach into the water-supply system. When live steam has been used for heating in a set-up like this, it has happened that whenever a boiler is shut down over night, with valves left open or leaking, the engineer couldn't find the water level in the boiler next morning, everything being soap bubbles.

Actually, the safest and most positive way of preventing water pollution lies in use of an auxiliary water system for urinals, water closets, drains, lawn sprinklers, and all purposes where the water might become contaminated. This system should be completely independent from the water-supply system used for drinking and domestic purposes. However, the latter system must still be protected by the various means outlined above.

In laying out a water-supply system for a building, the main points to be sure of are ample volume and sufficient pressure. Many times the main feeding a building is too small because of heavy meter or service charges based on the size of the line. Some utility companies have eliminated these charges and if the customer only has to pay for actual consumption, nothing stands in the way of using proper pipe sizes.

Avoid Low Pressure

Insufficient water pressure is another common cause of back-siphonage. The least pressure on the top floor of a building should be 20 lb. In existing systems additional fixtures are often added to supply lines barely large enough for the original fixtures. This procedure only increases the possibilities of backflow.

Cooperation between engineers, architects, building contractors, and health and water departments would help in solving some of the problems of water pollution. The answer does not lie entirely in mandatory regulations, since ways and means can always be found to get around the rules. What is needed is a real appreciation of the problem by engineers everywhere and laws strong enough to eliminate the health hazards of water pollution but not so strong as to be economically impossible.

A good way to begin lies in checking your own plumbing system now. If it's old there is a good chance it contains pollution hazards of one kind or another that should be fixed immediately.

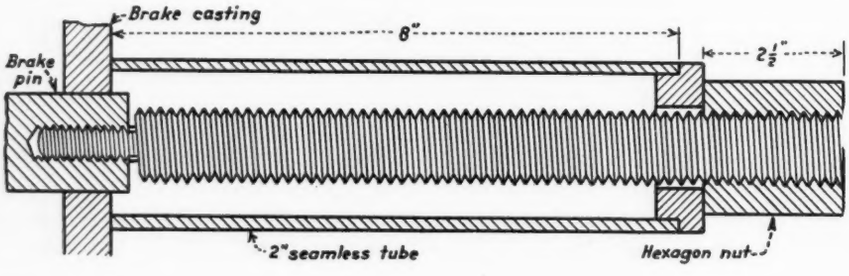
PRACTICAL AIDS TO OPERATION

Pull, Don't Drive Brake-Shoe Pins

WE EXPERIENCED CONSIDERABLE TROUBLE in our building with elevator-machine brake pins wearing and sticking and causing faulty application of the brake. Each brake has two or three pins on each side; two of these on one side of a brake are at P and P_1, above. Pin P is the fulcrum on which operating lever L works and P_1 connects the brake shoe to the operating lever. There are 246 of these pins on our elevators; proper maintenance of them is quite a job. As there is very little movement on these pins they tend to rust into place and wear on one side, which means they must be removed periodically, cleaned and lubricated.

To remove the pins, without having to drive them out, we made the pin puller, below. This consists of an 8-in. section of seamless-steel tubing, and a threaded 1-in. steel rod 12 in. long. One end of the rod (for 1½ in. length) was reduced to ⅞ in. diameter and threaded to screw into the end of the brake pins, which we drilled and threaded for this connection.

A special steel disk is placed around the pulling rod and against the end of the tube. Against this disk we tighten a hexagon nut 2½ in long. The photo shows the puller in position ready to remove a pin. This device pulls the pins easily and without injuring their ends, as frequently happened when they were driven out.



New York, N. Y. WM DEVAUGHN

Safety Reminders for the Power Plant

IN SMALL AND MEDIUM SIZED PLANTS the chief engineer is often responsible for the safety engineering work. The necessary cooperation of the employees under him will depend upon his reception of ideas and suggestions from them. I have in mind a boiler-room foreman who, when safety suggestions were made concerning his department, would raise so much furore about them that his men avoided these problems.

In one instance, the feedwater regulator blowdowns discharged into the open between the boilers, instead of being piped to a safe place. This had been reported several times but the foreman objected to a change, giving as a reason that unless the discharge could be seen, one could not be sure that the expansion tube was clear. When one of the company executives received a near-shower of hot water while walking by one of the boilers the foreman lost out to a more cooperative man.

I think an important factor in plant safety is housekeeping. "A place for everything, and everything in its place." Clean machinery, clear aisles, and dry floors are the rule in a safe power plant. All stairways and overhead catwalks should be kept clear. Because the "big-shots" seldom get up there is no reason for using these spaces for storage.

Gas masks are an important item in every safety program. Be sure that they are kept in good condition and that men know how to use them. Three men perished recently in an ash hopper because they did not use gas masks even though the company had them for just such purposes. Weekly safety meetings should include a gas-mask drill. Warn all employees of the dangers involved in unventilated ash-storage bunkers and hoppers and coal silos.

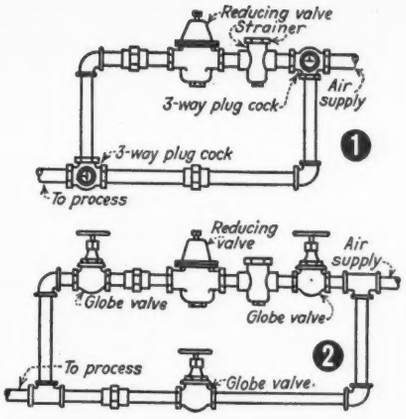
Another important factor in employee safety is the clothes a man wears while working. The safe worker in the power plant or shop will wear

trousers or overalls that are heavy enough. The jacket, if he wears one, will be tucked inside his overalls. His shirt or jacket sleeves, if long sleeves are worn, will be buttoned. He will wear hard-toe shoes, and cuff canvas gloves to protect his hands and wrists if his work brings him into contact with piping and other hot objects. The "raggedy-ann" and dangling necktie "dandy" getting the maximum wear out of last season's dancing slippers have no place around moving machinery.

Milwaukee, Wis. L W LARSON

Plug Cocks Simplify Reducing-Valve Hookup

THE USUAL WAY of hooking up a reducing valve is shown in Fig. 2. Here three valves are required in the connections. We have simplified and reduced



the cost of these connections one-third by using two 3-way plug cocks, Fig. 1. The plug cock also simplifies bypassing the reducing valve, as rotating the two cocks one-quarter turn will change the unit from reducing valve to bypass. With the valves, two must be closed and one opened or one closed and two opened to change from reducing-valve to bypass or vice versa.

Englewood, N. J. R BOETTINGER

Clean Pipe Inside After Bending

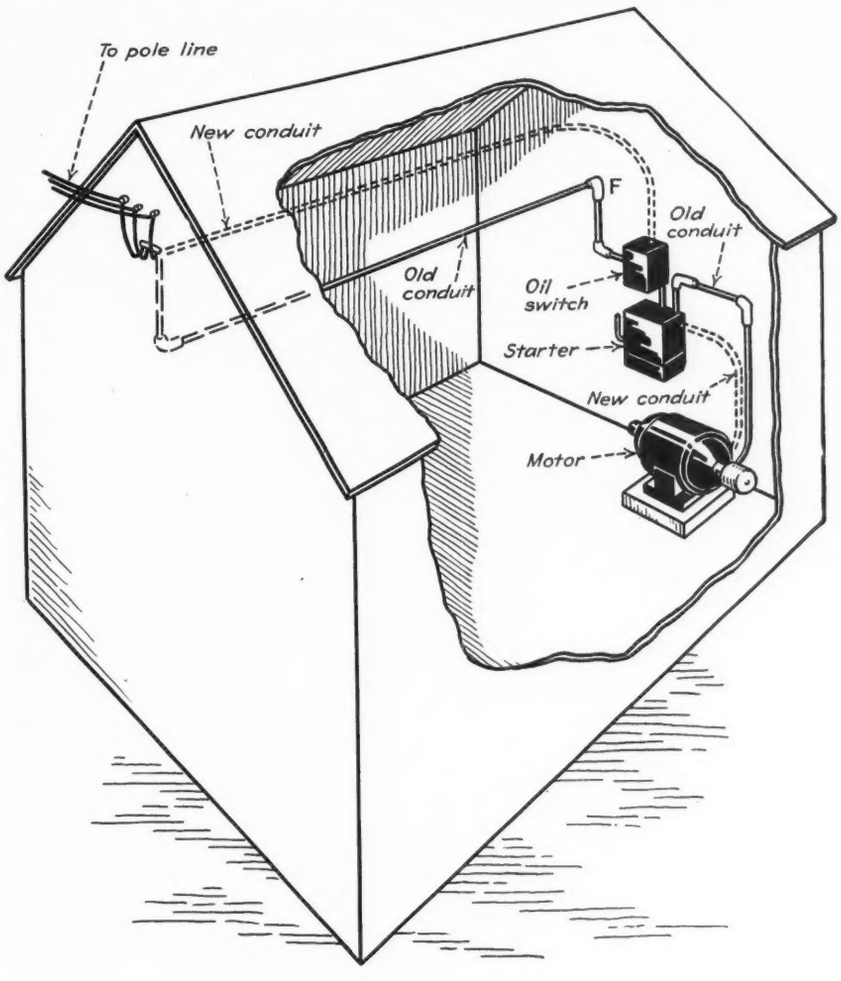
BEFORE BENDING BRASS, copper or similar pipes it is common practice to fill them with sand, lead or rosin, which is removed after the bending is completed. If the pipes are to carry liquids or air it is necessary to clean them thoroughly before installation. Sand is likely to become imbedded in the pipe and not be completely removed by mechanical means and rosin is likely to leave a film.

To clean thoroughly the inside of the bends I always use compressed air or steam. The latter is preferable because of its higher temperature and it also produces greater scouring action.

London, England W E WARNER

Too Many Bends in The Conduit System

THE FULL LINES in the figure show how the original conduit for wiring to a 40-hp, 2300-volt motor, was run in our plant. From the 2300-volt overhead line the wires came into the motor house and entered the conduit through a fitting with a 3-hole porcelain cover. Between this fitting and an oil switch the conduit made three right-angle bends, with two such bends between the compensator and the motor.



One day, during a lightning storm, one of the fuses on the pole blew and the wiring insulation failed in fitting *F*, burning a hole in it. The conduit system was well grounded, consequently no other damage was done. When we pulled out the old rubber-covered wires to replace the damaged one we found that their insulation was in rather bad shape, so decided to replace them with new ones having varnished-cambric insulation.

To remove as many bends as possible from the conduit we replaced it as shown by the dotted lines. In this, it was possible to replace all the right-angle fittings by two long-radius bends. While this may be an extreme case, it does illustrate that at times too many fittings are used in conduit systems.

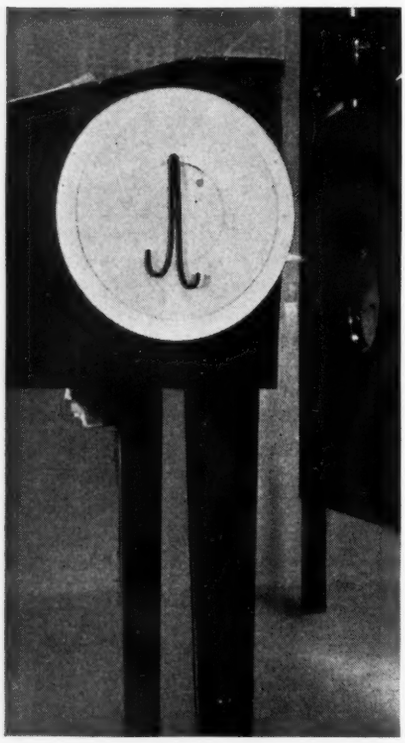
When high-voltage lines are brought into manufacturing plants, make the insulation factor of safety as high as possible by using the best grade of insulation, long-radius bends in the conduit and a minimum of them, and by adequately grounding the conduit system. We have followed this practice and have had no failures of varnished-cambric insulated cables used to replace rubber-covered wire. Care has been taken when pulling the wires into the conduit and whenever there is a possi-

bility of moisture getting in we use lead-covered cable. In all cases the conduits are vented with small holes in the under side of the low points.

Sayreville, N. J. K B HUMPHREY

Ready-Reference Chart Holder

IN OUR PLANT it was necessary that recent charts from recording thermometers and other instruments be readily available for comparing with those on the meters. We solved this problem by putting a long bolt into the end of the process supervisor's desk. The head of the bolt was filed down to a size that would pass easily through the hole in the center of the charts and the bolt extended about 6 in. out from the desk.



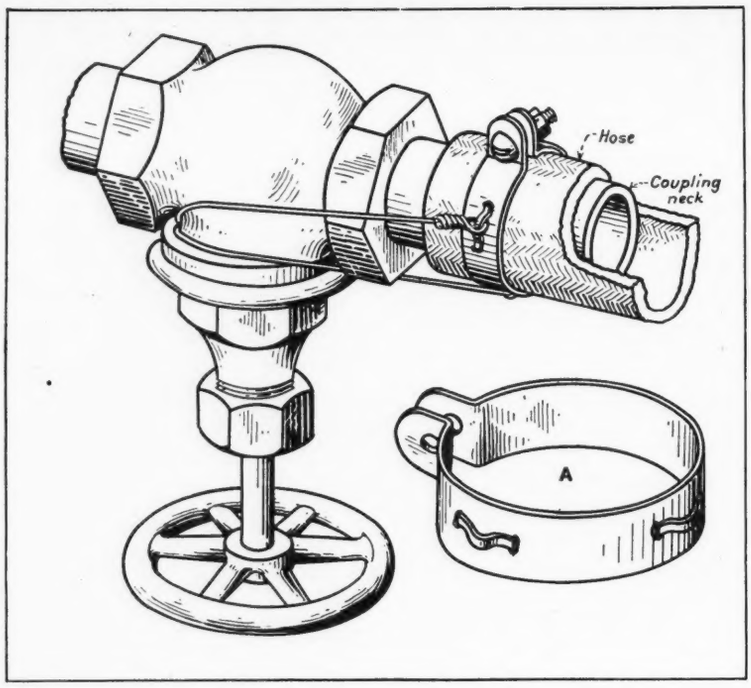
To hold the charts vertical and flat on the bolt we bent a piece of ¼-in. rod into the shape of a narrow fancy "A," to fit over the bolt, as in the photo. The two sides of the "A" are bent almost together so that they grip the bolt and can be easily removed by lifting straight up. Charts thus filed are held flat and handy for consultation.

Houston, Texas M T PATE

Oil Stains Removed from Concrete

I HAVE HAD TO REMOVE OIL STAINS from concrete several times and have found the following mixture very satisfactory. Mix one ounce of oxalic acid in one quart of water, then add enough wheat flour to form a paste that can be applied with a brush. Apply the paste to the stain and leave for 24 hours, then wash off with clean water.

London, England W W WARNER



Air Hose Anchored on Nipple

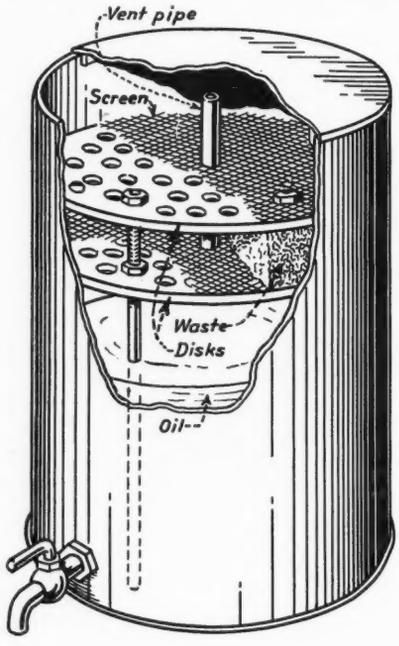
HAVING EXPERIENCED the disagreeable accident of an air hose blowing off the coupling nipple, we decided to prevent it happening again. First, we welded loop lugs to the hose clamp in three places, as at *A*. Then when the clamp was replaced we wired it tightly back onto the valve. This eliminated any chance of hose and nipple separating.

Penacook, N. H. C H WILLEY

A Simple Primary Oil Heater

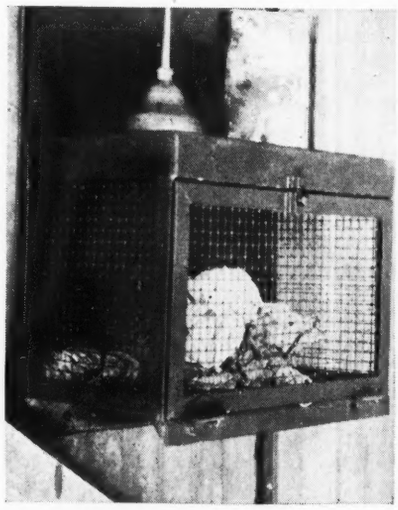
A THICK COATING of sludge settled to the bottom of our dirty-oil tank, which meant we had to take the tank out and clean it. Apparently most of this material came from drip pans and drain lines, so we decided to filter partially this oil before it went to the dirty-oil tank. To do this job we made a filter from a 5-gal red-lead can.

Part way down in the can we supported the filtering element. This was made from two sheet-metal disks fitted snugly into the can. We drilled a large number of 1-in. holes in these disks and soldered a fine-mesh screen wire to their top surface. They were then assembled on three vertical rods as shown to support them in the can. A short length of pipe passing through the two disks vented the bottom compartment of the filter. A drain valve connected in near the bottom of the can completed the construction work. The space between the two disks was filled with waste. When the waste becomes clogged with dirt from the oil the filtering element is easily removed



and cleaned. This little trick has saved a lot of bother and unnecessary cleaning farther along in the oil-filtering system.

New York, N. Y. S M ELONKA



Screened Cages Cut Fire Hazards

FORESEEING the potential dangers from spontaneous combustion in engine and boiler rooms, where oily wiping cloths and waste might accumulate, one company installed light metal screened cages on the walls for temporarily disposing of such inflammable materials. As shown in the photo, the front of each of the well-ventilated receptacles opens against the pressure of two spring hinges, so that the door will always close and latch when released.

These enclosures are 17 in. long, 10 in. wide, and 12 in. high. The screen-wire sides and light angle-iron corners are welded together and to the top, bottom and back made of a light sheet metal. The cages are bolted to the wall at any convenient place where there is likely to be accumulation of inflammable material.

Alhambra, Calif. G M WILSON

Chart for Cutting Flange Gaskets

THE DIMENSION CHART shown here provides increased convenience and accuracy when cutting gaskets for pipe flanges. This chart is applicable to flange gaskets for pipes up to 10 in. in diameter. It can be used when cutting gaskets for extra-heavy and medium standard and low-pressure, ring or full-face flanges. The following instructions tell how to set the dividers for laying out gaskets, or the gasket cutter can be quickly set to the proper dimensions.

Place one point of the dividers at center * at the bottom of the proper OD column. Then adjust the dividers to bring the other point into the center of the circled dot opposite the figure representing the size of gasket desired. With this setting of the dividers, describe a circle on the packing. Then proceed as before, using the "Size of Pipe ID" column, and describe a second circle on the packing, using the same center as in the first operation. The values on the chart are the radii of circles the size of the gasket required for flanges of the dimensions given.

Abilene, Texas R R HOWINGTON

GASKET DIMENSIONS

Extra Heavy & Medium Flanges		Size of Pipe ID	Standard & Low Press. Flanges	
Ring O D	Full Face O D		Ring O D	Full Face O D
	9" ⊙			10" ⊙
	8" ⊙			9" ⊙
10" ⊙	7" ⊙		10" ⊙	8" ⊙
9" ⊙	6" ⊙		9" ⊙	7" ⊙
8" ⊙				
7" ⊙	5" ⊙		8" ⊙	6" ⊙
	4½" ⊙			
6" ⊙	4" ⊙	10" ⊙	7" ⊙	5" ⊙
	3½" ⊙	9" ⊙		4½" ⊙ 4" ⊙
5" ⊙	3" ⊙		6" ⊙	3½" ⊙
4½" ⊙	2½" ⊙	8" ⊙	5" ⊙	3" ⊙
4" ⊙		7" ⊙	4½" ⊙ 4" ⊙	2½" ⊙
3½" ⊙	2" ⊙		3½" ⊙	
	1½" ⊙	6" ⊙		2" ⊙
3" ⊙			3" ⊙	
2½" ⊙	1¼" ⊙	5" ⊙	2½" ⊙	1½" ⊙
	1" ⊙	4½" ⊙		1¼" ⊙
2" ⊙		4" ⊙	2" ⊙	1" ⊙
1½" ⊙		3½" ⊙		¾" ⊙
1¼" ⊙		3" ⊙	1½" ⊙	
1" ⊙		2½" ⊙	1¼" ⊙	
		2" ⊙	1" ⊙	
		1½" ⊙	¾" ⊙	
		1¼" ⊙		
		1" ⊙		
*	*	*	*	*

Copyright, 1938 R R Howington

READERS' PROBLEMS

Questions from Our Readers

Orifice in Gage Class

Question 1

WE USE A $\frac{1}{2}$x16-*in. Pyrex gage glass and a safety glass on each boiler. In the lower shutoff cock we use a thin disk with a* $\frac{1}{8}$-*in. hole in the center, thus forming an orifice in the end of the gage glass. This arrangement adds considerably to the life of the glass. We would like to have the opinion of* POWER *readers regarding possible operating or safety disadvantages of this scheme*—JBC

Breakage of Wedge Bolt

Question 2

WE HAVE BEEN TROUBLED *by the breaking of the top wedge bolt for adjusting the crankpin brasses of the connecting rod of our Corliss engine. The connecting rod has a solid end with a bolt in the upper and lower ends of the adjustable wedge. The top bolt has broken several times just under the head and once or twice about where it enters the wedge. What is the remedy?*—AAF

SUITABLE answers from readers will be paid for if space is available for publication. Answers accompanied by practical drawings or photographs will command additional pay.

Cleaning Boiler Tubes

Answers to Sept Question 1

The Question

DRAFT LOSSES *caused by fuel deposits on tubes force us to bring down our boilers for cleaning at intervals of from 6 to 12 weeks. These deposits consist of soluble salts when we burn hot asphalt, or of lime and calcium sulphide when we burn fuel oil. We alternate these fuels according to market conditions.*

In the past we cleaned the exterior surfaces of our water-tube boilers by punching and blowing with 90-lb air, allowing the loosened ash to fall to the furnace floor, where it is scooped away. Recently we started using water to wash the tubes. The water softens the ash, dissolving a portion of it, making the boiler easier to clean. In addition it reaches otherwise inaccessible surfaces and cleans to the metal surface. We allow the furnace to cool thoroughly before using water and heat it up very slowly afterwards.

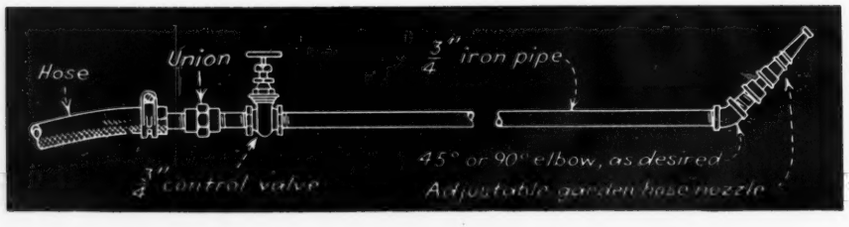
We wonder whether this injures the furnace settings and baffles. Does the water fall into small crevices where it is trapped when the furnace begins to expand as it warms up, so that steam formed must burst through? Or does the water evaporate before the small crevices and pores close?

Occasionally load conditions are such that we cannot shut down a boiler for cleaning, so we wash the tubes carefully with a limited amount of warm water which evaporates before it can fall into the hot furnace. We are careful to avoid the baffles. Are the stresses set up in the metal of such a nature as to make this practice dangerous?—DF

Proper Water Lancing OK

ABOUT 10 OR 11 YEARS AGO POWER carried a discussion regarding the proposed cleaning of the fire side of U. S. Navy water-tube boilers by using a water stream to dissolve salt, carbon, sulphate, etc, deposited on the tubes and drums. At that time I related some observations and experiences with this method of cleaning obtained as an insurance-company boiler inspector in southern Texas and the Republic of Mexico. Since that time I have had occasion to examine several of these boilers and their settings after dismantling.

The method found easiest and best, and without deteriorating effect on settings, baffles, or the boiler proper, differs slightly from that described in the question. It has been used on boilers from 1500 to 8000 sq ft of surface, of both straight and bent-tube types. Boilers are cooled until the surface inside the setting runs about 140-165 F. Water temperature ranges from 130 to 180 F and the best procedure involves use of a hand lance like that in the sketch. The pipe should be long enough to allow the operator to reach all parts of the setting through the cleanout and explosion doors. The valve between the pipe of the lance and the hose permits shutting off the water when adjusting the nozzle and changing elbows behind the nozzle, as needed to reach all corners of the setting.



With this method there is no serious deterioration of the brickwork or baffles, as refractories are hot enough to prevent absorption of water below the surface and to dry the refractory and metal surfaces soon after washing is completed. The temperature is not high enough to cause checking or cracking of the refractories by contact with water. Where baffles form pockets at headers or drums, provision should be made for draining water and sludge and care should be taken to see that all deposits are dissolved and removed where tubes enter headers or drums and pass through baffles. Partially dissolved deposits seem to cause more rapid corrosion than new deposits, and where water is used and the settings are too cold to dry promptly, corrosion results at tube ends and where refractories come in contact with boiler metal. Stirling boilers subjected to this method of cleaning for several years show no evidence of serious corrosion on blank heads or lower drums when dismantled for moving.

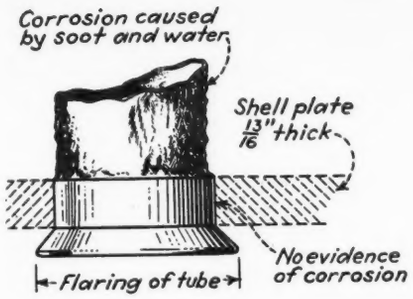
In one plant, 6000-sq-ft, 135-lb, longitudinal-drum, straight-tube boilers, with cast-iron-fin superheaters above the first pass, were fired with heavy oil badly contaminated with sludge and refinery waste. Despite regular and heavy use of soot blowers operators ran into considerable trouble with hard deposits on tubes and superheaters and frequent setting repairs were required. To try out the washing method, operators took a boiler that would not produce 36,000 lb per hr and ran a stack temperature of 800 F. After cleaning, the flowmeter showed 45,000 lb per hr and flue-gas temperature was down to 480 F. When all eight boilers in the plant were cleaned regularly, six instead of seven could carry the load and a substantial saving was made in setting repairs as well as fuel.

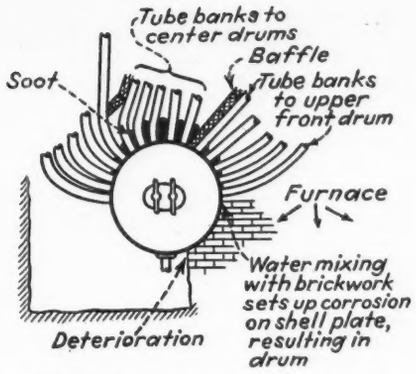
When boiler or setting repairs are to be made, cleaning the boiler first will expedite the work and reduce danger of eye injuries from salty or acid particles in the deposits. Incidentally, the lance described, without the elbows and with the nozzle set to a fairly fine spray, removes the sandy deposits from the tubes of fire-tube boilers, encountered when burning some grades of natural gas, better than any flue-brush, steam lance, or scraper I have ever found.

Houston, Texas H E FLOWERS

Don't Use Water

WATER SHOULDN'T BE USED to wash down a water-tube boiler, even though it seems to do a better job than soot blowers or steam lances. For example, in a 3-drum or Stirling boiler there is a section of the lower or mud drum where all the tubes from the upper drum converge. This mass of



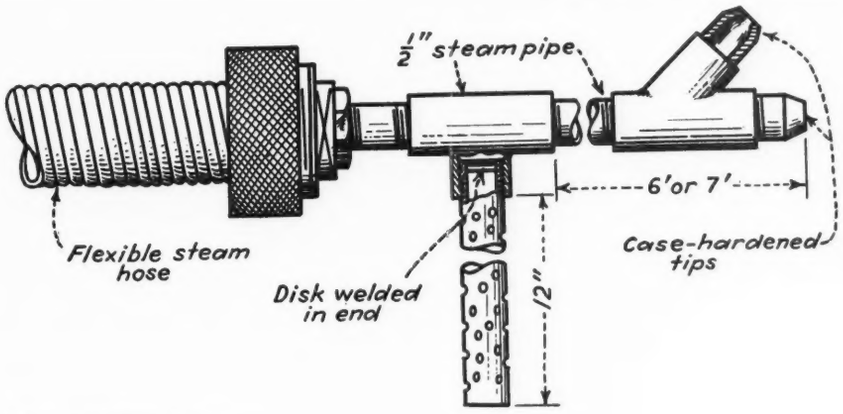

Tube banks to center drums
Baffle
Soot
Tube banks to upper front drum
Furnace
Water mixing with brickwork sets up corrosion on shell plate, resulting in drum
Deterioration

tubes forms a reservoir for practically all the soot, especially in the middle pass. Soot blowers cannot remove the soot and flyash from between the tubes, and this becomes caked and hard. Attempts have been made to clean the tubes and drum surfaces without much success; the heavy deposits wash away but the small amount that stays becomes, when wetted down, a menace to the boiler because of its corrosive action. This corrosion cannot be seen and there are no easy ways to determine the depreciation of tube walls. Hydrostatic testing will only reveal weakness that is well advanced.

In the case of the drum shell plate, which is partly buried in the brick work at the rear of the furnace setting, the bricks cover that portion of the shell from a few inches below the bottom or first banks of tubes in the furnace to within a few inches of the blowoff pipe; roughly a fifth of the total surface of the shell plate is against the brickwork. Wetting down the boiler, to wash away soot and flyash, constitutes a hazard at this point since the brickwork is at its maximum thickness at this section. The brickwork exposed to products of combustion becomes spalled and more open to chemical action than new or clean brick. Water of any temperature would cause collapse of the setting, if used before walls or linings are sufficiently cooled. Water combines with soot, flyash, and brick, setting up a chemical action causing corrosion.

If DF's boilers are of the Heine type, there should be no trouble in keeping tube passes free of soot, using soot blowers installed at strategic locations. In some cases, rebuilding the horizontal baffling to a vertical arrangement has met with success.

Grand Rapids, Mich. J M GORRIE



Use Steam Lance

THE PRESENT method of removing soot by water hose should be discontinued for obvious reasons, one of which is the incalculable strain set up. This strain may cause tube ends to pull out when the boiler goes back into operation. If soot blowers cannot be installed, I suggest using live steam as shown in the accompanying sketch.

This rig can be made up easily; the only machining that may be required is on the two nozzle tips. These should be casehardened. The handle of ½-in. pipe should be plugged at one end and holes drilled along its length to act as air vents. The tool will have to be handled with asbestos gloves or it may be asbestos wound, as suits the job. Nozzles of different design and shape can be applied as required.

Kearny, N. J. GEORGE MCNALLY

Water in Engine Cylinder

Answers to Sept Question 2

The Question

WE HAVE *a single-valve high-speed engine supplied with steam through a pipeline about 250 ft long. There is a standard-size separator in the steam line, but we often have trouble from water getting into the cylinder. This once caused a crack-up when the engine was started. How can we prevent this trouble?*—DLW

Check Three Points

THE FACT THAT A CRACK occurred when starting up suggests that possibly sufficient care was not given to warming up of both piping and engine. Of course, when warming up, all condensation should be drained off. If this matter was properly attended to, it would appear that there are three possible sources of trouble. The first point of attack would seem to be the separator and if possible it would be a good thing to get in touch with the maker to get his opinion as to why it isn't taking care of the water. As the burden of proof lies largely with him, he will no doubt be pleased to cooperate and find out where the real trouble lies.

If the separator is found to be adequate, under normal conditions, there may be excessive condensation due to inadequate insulation of the steam main, which is of considerable length and may be larger than absolutely necessary. If the trouble lies here, it is only a matter of spending the money to provide the required insulation. At the same time it might be well to ascertain whether there is not an intermediate point where a trapped drain outlet might be advantageously provided. If the trouble is not found between the boiler and engine it is probably due to excessively wet steam, or priming. As modern boilers are usually well designed, this is most likely due to water conditions and should receive the attention of a treatment expert.

Bloomfield, N. J. J O G GIBBONS

Check Steam Quality

THE FIRST POINT TO CHECK is the quality of steam being delivered by the boiler. It should be dry steam with a maximum moisture content of 2%. The throttling calorimeter will answer this point. Presumably the steam supplied to the engine is taken from the highest point in the boiler, and accordingly the moisture content is probably sufficiently low. Nevertheless, the steam must travel 250 ft before entering the cylinder, and if the line is not adequately insulated, or an improperly sized pipe is being used, condensation between boiler and engine will occur, seriously increasing the moisture content of the steam. If the separator is not located as close to the throttle as convenience permits, condensed water cannot help but enter the cylinder during operation.

A convenient check on the fitness of the steam line is to note the pressure at the boiler stopcock and compare it with that before the engine throttle valve. If the latter is more than 3% lower than the boiler delivery pressure, excessive line condensation is the answer. This can be remedied by properly insulating the line or changing the pipe diameter to fit proper steam delivery (assume steam velocity to range from 8000 to 12000 fpm) or both.

It appears that DLW's engine is operated intermittently. If this is the case, and proper precautions have not been taken as outlined above, there will always be an accumulation of water above the throttle valve prior to starting the engine. The amount of water accumulated depends upon the length of time the engine has been shut down. This condition undoubtedly explains why the engine cracked up when started on one occasion.

If DLW's problem is mainly concerned

with engine starting, it is further suggested that a check-up be made on the kind of lubricant being used. If the cylinder wall is not covered with a tenacious film of properly compounded lubricant upon starting, any water above the valve entering the cylinder will tend to wash the lubricant from the contact surfaces. This will cause insufficient lubrication during the next few strokes, and such operation is obviously conducive to wear, loss of compression, and steam blow-by past the piston rings. As a result, noisy operation and possible engine "smashing" may occur. This condition can be corrected by using a grade of cylinder oil which contains a sufficient amount of high grade animal or fixed oil to promote the formation of an extremely cohesive film of emulsified lubricant. Such a lubricant should adequately resist the washing action of any water that might be present.

New York, N. Y. BRIAN CORRIGAN

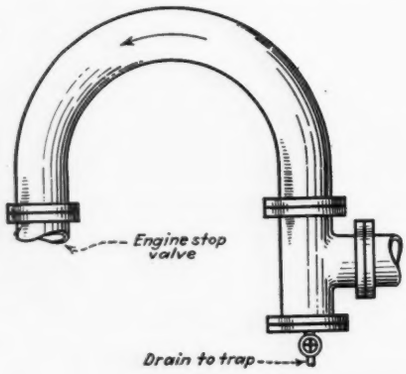
Use Tee and Bend

SEVERAL FACTORS may be contributing to water reaching the cylinder, including high steam velocity due to restricted pipe area, piping inclined towards instead of from engine, separator in wrong location, etc. The steam velocity can be reckoned by a simple formula:

$$Velocity = \frac{Area\ of\ Cyl \times Piston\ Speed\ (fpm) \times Cutoff}{Area\ of\ Pipe}$$

The velocity should not exceed 7000 fpm in this case.

The 250-ft line should be kept full of



steam at all times. To safeguard the engine from the moisture hazard I suggest fitting the tee and bend next to the engine stop valve as shown in the sketch.

Kearny, N. J. GEORGE MCNALLY

Follow Check-List

THE FOLLOWING LIST may include something that has been overlooked. Let's start at the boiler:

(1) Be sure the boiler is not sending out slugs of water with the steam.

(2) If there is a vertical line with a gate valve in it, say at the header, there should be a small free-blow valve installed by tapping the body of the valve just above the gate. Drain through the free blow before opening the valve.

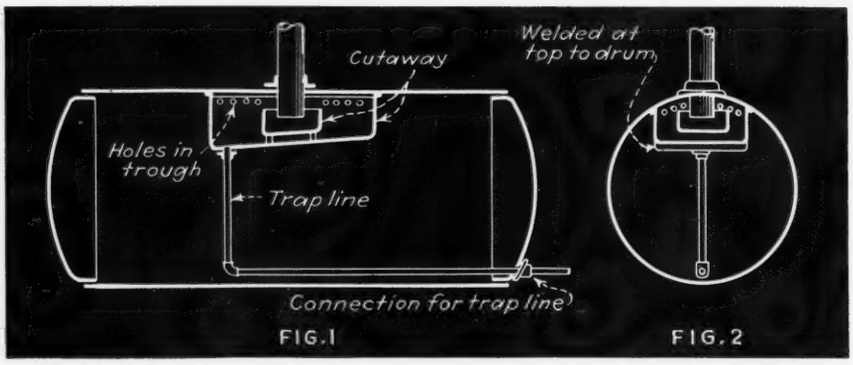
(3) See that any vertical leg or other water-collecting place in the line is properly dripped with a trap. To be safe, such a spot should be drained by hand before starting up the cold line.

(4) If the separator is truly "standard", it should have somewhere near twice the diameter of the engine cylinder. If it is old, it might be inspected through a hand hole, if any, or at the pipe connections, to see if the baffle is in place and not rusted through. A separator should be large enough to slow up the steam, to let large quantities of water settle out. The separator should be drained by a trap with a bypass. A water gage glass on the separator will tell whether the trap is working and whether it is necessary to open the bypass when the line is cold.

(5) If there is a vertical line above the throttle valve, it should be drained before opening the throttle valve, and the steam line up to the throttle valve should be warmed up by having the steam on.

(6) The engine cylinder should be drained until it is started and warmed up.

Birmingham, Ala. J W NORTH



Baffle Steam Outlet

WHILE DLW DOES NOT MENTION anything about his boilers, I assume his carryover starts there. The sketches show an inexpensive solution similar to one tried on two of our boilers. The trough, made of ¼-in. boiler plate, can be fabricated and attached by welding. While the size can be changed to meet local conditions, it should be ample and I suggest that it be about 6 ft long, 20 in. wide, and 8-10 in. deep. The end at the trap line outlet should be about 1½ in. deeper than the other end.

Holes about ¾ in. in dia placed as close together as possible along the top edge of the trough admit steam to the header. The connection for the trap line can be welded to the bottom of the trough at its lower end. The smaller trough keeps the steam rushing into the header from picking up any water that may seek the lower end of the main trough. This smaller trough can be made of the same material and should be larger in diameter than the steam header by at least 6-8 in. It can be supported from the trough bottom but should be at least 2 in. from the bottom and the sides of the trough should be at least 4-in. high.

The steam header will be flush with the drum shell, so an extension should be welded to the drum, extending down in the smaller trough about 1 in. The trap line from the trough should be brought down near the bottom of the drum and if a suitable outlet in the drum cannot be found, then a connection must be welded or rivetted to the drum at the end. After the line is out of the drum, it can be run in any way desired to a trap. It should be at least 1¼ in. in dia.

Bismarck, N. D. LESLIE BRADLEY

Separately Fired Superheater

DLW'S PROBLEM can be solved easily by installing a separately fired superheater. The design may be for either manual or automatic control of the fire and it will be necessary to consider whether to supply sufficient capacity for supplying saturated or superheated steam to the engine in question.

It is well known that a single-valve engine will operate satisfactorily with steam superheated to 50 F or even to 100 F without the necessity of supplying it with special oil. If the engine is a large one, there will be an advantage and economy in a reduction by 25% to 50% in the quantity of steam consumed.

Several years ago I installed superheaters in four hrt boilers in an ice plant, with results that astonished me. The savings on coal over the previous year totaled nearly 30% and the plant operated much more satisfactorily than with saturated steam.

New Orleans, La. H J MALOCHEE

Has Exhaust Line Been Checked?

DLW ASKS "How can we prevent this trouble?" The answer is he can't prevent it entirely, that is, condensation reaching his engine; but he can do something about it which will lessen his trouble considerably. Assuming that the throttle valve is mounted on the engine cylinder or steam chest, there should be a good separator right on top of the throttle and another about 10 or 15 ft ahead of it in the pipeline. If the steam line drops down from the ceiling

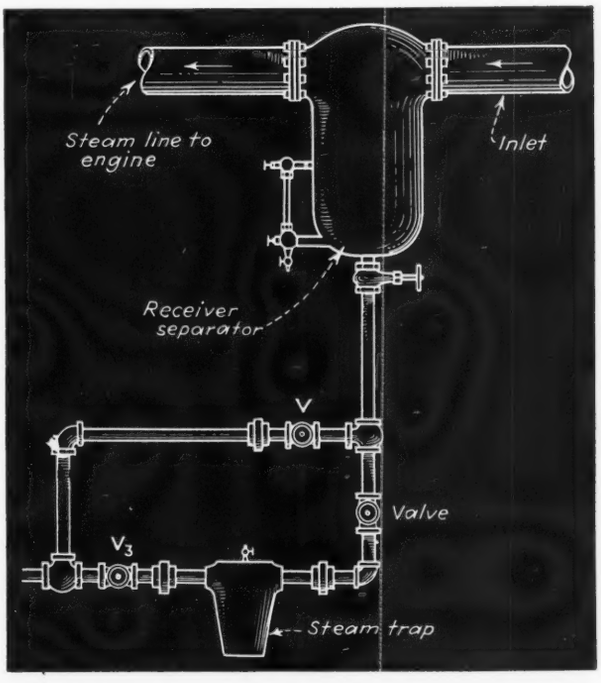
to the engine this other separator should be just ahead of the elbow where the line turns down. Both separators and the throttle valve body should be continuously drained through good traps. And the traps, which should have bypasses, should be checked at least once during each watch period.

Is the steam line insulated properly? If not, insulating it will help a lot. And how about the exhaust line? Possibly the water that caused the crack-up may have come from there. I know of an engine room on our eastern coast that contained six high-speed engines, the exhaust lines from which ran in trenches in the floor and turned up into a "utility tank" from which a single line ran to the exhaust head on the roof. Two engines were wrecked by water sucked up out of the under-floor exhaust lines because the operating engineer was careless about his traps. It was found that the traps which should have drained these lines were inoperative and also that the 1½-in. pipes from the exhaust lines to the traps were plugged with rust.

San Diego, Calif. C A LeQuesne

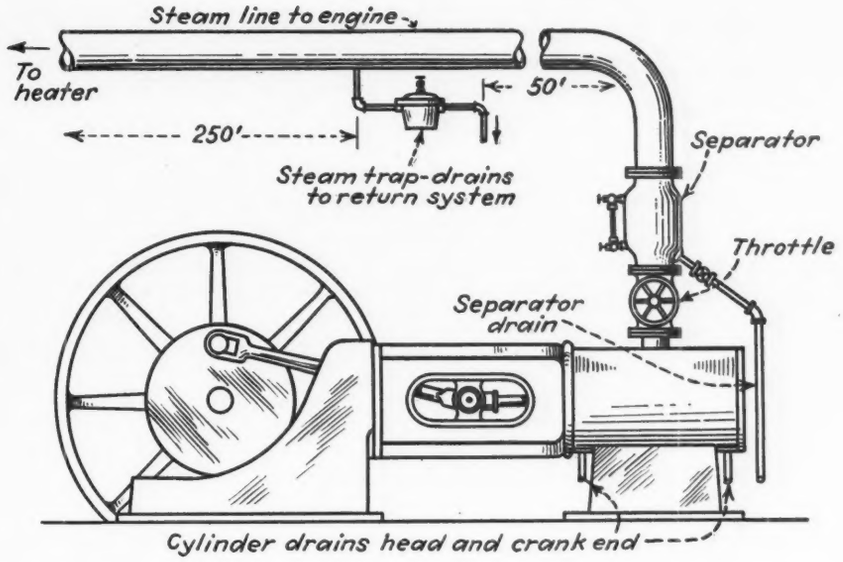
Improper Separator Drainage

DLW's trouble seems caused by a too-small separator or improper drainage of the separator. For such installations a receiver separator should be used, provided with a large well which acts as a reservoir for steam and a receptacle for water separated from the steam. The steam in the reservoir permits the engine to run smoothly with a variable load even when a long steam line feeds the engine. This surplus steam also reduces vibration.



With poor drainage, water collects in the separator and when a sudden load is applied to the engine the increased velocity of the steam causes priming, which is apt to crack a cylinder head. A trap, connected as shown in the diagram, should be used to remove condensate from the separator. This is no doubt what has caused DLW's trouble, as he states that it was experienced in starting. After shutdown, steam in the line condensed and filled the separator because of poor drainage; then when the throttle valve was opened a severe case of priming occurred.

S Vineland, N. J. Tarquin de Rosa



Need Traps

If I were in DLW's place, I would install a trap of proper size in the header, one about 200 ft from the boiler, and one connected to the valve chamber. The first would take care of condensate in the steam line from the boiler to the steam valve on the header. The trap in the pipeline would take care of condensate from the steam valve on the header to the pipeline trap. The trap on the valve chamber would take care of condensate or water that might get past the steam separator. If there is any chance of water getting past the trap on the valve chamber, when starting up, the drain valves will be open to take care of this condition. If water continues to appear when starting up, water in the boiler is being carried too high, but even with water a little high I believe these traps will take care of the problem.

Philadelphia, Pa. W T Mullen

Pipeline Too Small?

Carryover may be due to a number of causes which may be present individually or collectively and in any case it is aggravated by the use of high-speed engines.

One of the causes is steam piping being too small to take care of peak-load demands, and the necessarily high velocity of steam materially assists in picking up water and sweeping it over onto the engine. If this is the cause, little can be done other than to increase the size of piping. It is difficult to remedy by traps and drains as the steam is moving too rapidly to permit this to be very effective.

Another very common cause can be traced to high concentrations of alkali salts in the boiler water. This is also aggrevated by the use of high-speed engines and is very apparent during the first few moments when load is applied after starting up. A concentration which may be satisfactory at light loads may give trouble by carryover at heavier loads. If this occurs too often on starting up, the boiler-water concentration at this time should be checked.

If the condition exists only during a variable load, concentration should be reduced and carried at a degree unaffected by the highest peak attained. This permissible degree is best found by experiments in the particular plant where the carryover condition exists. Also it is possible that, owing to the long length of pipe, it is beyond the capacity of the separator to handle the excessive amount of condensate usually found under this circum-

(Continued on page 140)

SHORT QUESTIONS — QUICK ANSWERS

General Plant Practice

Q—What is the difference between an impulse turbine and a reaction turbine?

A—An impulse turbine has expansion of steam in all nozzles; there is a large pressure drop from stage to stage, few stages are used, and high steam velocities result. The reaction turbine is designed for minimum expansion of steam in nozzles, a greater number of stages with low pressure drop per stage, and lower steam velocities. The wheel of the impulse turbine is rotated by impulses from steam expanding through the nozzles and being directed onto the blades. Reaction-turbine blades serve as nozzles, expanding the steam to produce velocity.

Q—If you were called upon to find out if a plant should be changed from non-condensing to condensing, give all the items that should be considered.

A—(1) The reason for the proposed change, (2) the amount of exhaust (low-pressure steam) required for heating and/or process load, (3) the availability of cooling water, (4) the cost of cooling water, its preparation (algae control), and cost of recooling if necessary, (5) cost of fuel, (6) the amount and required treatment of makeup water, and (7) net savings anticipated.

Q—In computing the amount of radiation to be installed in a building, what is the number of Btu per hr that each sq ft of radiation emits?

A—250 Btu per sq ft per hr is a reasonable estimate for cast-iron radiators. Actually, however, the type of radiation and data on the temperature differentials would have to be known in order to make accurate computations.

Q—What is the difference between a direct and an indirect heating system?

A—A direct heating system is one in which the radiating surfaces are in each room to be heated. In an indirect system, the primary heating element is in a centrally located radiator, and heat is transmitted and distributed by convection in the form of air, circulated usually by fans.

Q—What is a "split heating system"?

A—A split system is a combination of the two systems described in the question and answer immediately preceding.

Q—What are the five main items to specify when ordering a fan for ventilating service?

A—(1) Price, (2) capacity in cubic feet per minute, (3) efficiency, (4) rpm, (5) discharge pressure.

Q—What term is the standard for rating mechanical refrigerating units?

A—Tons of refrigeration per 24 hours (1 ton of refrigeration per day is equivalent to 12,000 Btu per hr).

Q—In a vacuum steam heating system, what is meant by the "wet return" and the "dry return"?

A—A wet return is introduced into the boiler below the normal water level so that short-circuiting through the radiators will not occur. The dry return extends into the steam space of the boiler.

Q—Can a 40-hp boiler, operating at rating, fully supply steam to a 1-pipe steam-heating system containing 7200 sq ft of radiation? Omit piping tax and allowance for morning pickup, but show all calculations in arriving at answer.

A—Assume an average room temperature of 70 F, a radiator temperature of 220 F, and a heat transfer of 1.7 Btu per sq ft per hr per deg temperature differential. Then 7200 x 1.7 x (200−70) = 1,836,000 Btu per hr heating load. The 40-hp boiler supplies 1200 lb of steam per hr to the radiators at 5 lb per sq in. g pressure at 100% rating. Total heat of steam at 5 lb g saturated (from steam tables) is 1156 Btu per lb, so the boiler supplies 1156 x 1200 = 1,387,200 Btu per hr. If the returns are at 180 F, then the heat in the returns is 1200 (180 — 32) = 177,600 Btu per hr. The net heat available for radiation is 1,387,200 — 177,600 = 1,209,600 Btu per hr. Thus, the boiler has not enough capacity for the conditions.

Q—What is meant by "Relative Humidity"?

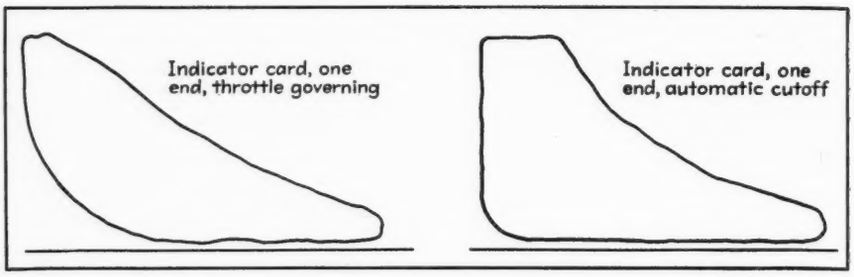
A—Relative humidity is the *ratio* (expressed as a percentage) of the actual amount of moisture in a unit volume of air to the amount of moisture the same unit volume would contain if saturated, at a given temperature.

Q—Name four preventable boiler losses and two inherent or unavoidable losses.

A—Preventable losses are excessive flue-gas temperature, haphazard blowing down, excessive safety-valve blowing, substantial amounts of unburned combustible. Two inherent losses result from radiation and "reasonable" loss of heat in flue gas.

Q—Sketch an indicator diagram to show the difference between governing an engine by throttling and by automatic cutoff.

A—See sketch.



Figuring Tank Capacities

By PHIL SWAIN

▶ FIGURING THE CAPACITIES OF TANKS is part of the everyday engineering job. Many tank-capacity tables are available, but it is always well to be able to figure rapidly without these tables, if need be.

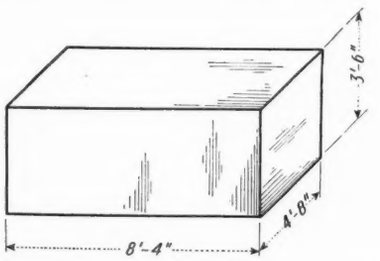
Tank dimensions are generally measured in feet and inches, but these compound numbers are inconvenient to multiply, so use the measurements in inches straight, or in feet and decimals. If you turn inches into decimal parts of a foot, one decimal place is close enough for most tank work. To show relative convenience of the two methods, we will work some of the following problems in feet, some in inches:

Before starting note the simple geometrical and other facts given in the box below. All of this data should be memorized because of its constant usefulness.

Problem (Fig. 1): What is capacity of rectangular tank 4 ft 8 in. x 3 ft 6 in. x 8 ft 4 in.?

Dimensions in feet and decimals are 4.7 x 3.5 x 8.3. 4.7 x 3.5 = 16.4, discarding second decimal place. 16.4 x 8.3 = 136 cu ft, discarding both decimal places. Volume in gallons is 136 x 7.5 = 1020 gal. Weight of water contained = 62.4 x 136 = 8486.4 lb, call it 8490 lb.

In working this simple problem we have



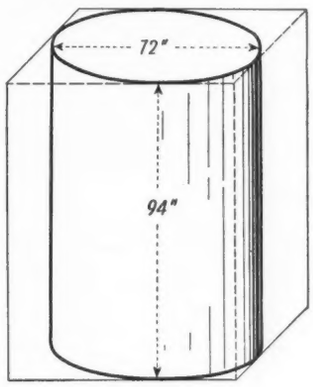
Capacity of this tank figures 136 cu ft, 1020 gals, 8490 lb of water

showed how time can be saved by dropping final figures after each operation. A common error of practical men is to "save" all the figures. After several divisions and multiplications the figures run halfway across the page and give an appearance of accuracy. This "accuracy" is imaginary, because the errors of tank measurement will throw the result out a certain amount anyway.

For example, in the last operation above, we discarded 3.6 lb to round out the figure to 8490 lb. How many engineers think they can measure this tank and figure the actual capacity correctly to 4 lb in a total weight of more than 4 tons of water? In the following problems the results will be rounded out in the same way, but without comment. Note that in each case we carry the actual figures for 3 or 4 digits, not more than 4, and use ciphers after that.

Problem (Fig. 2): What is the capacity of a flat-ended, round, vertical tank 72 in. in diameter and 94 in. high?

Note that this tank is a cylinder and that the volume of a cylinder is 78.5% of the volume of the rectangular box it fits into. First figure volume of the imaginary box. Volume of box (in cubic inches) = 72 x 72 x 94. 72 x 72 = 5184, say 5180. 5180 x 94 = 486,920, say 487,000 cu in.



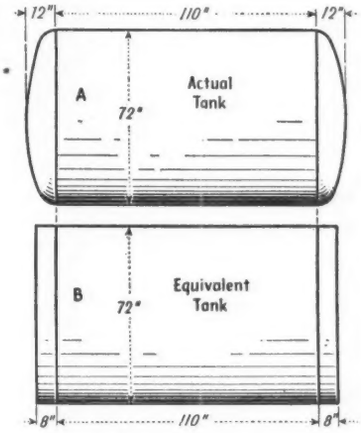
Capacity of this tank is 78.5% of rectangular tank of same dimensions

Volume of tank = 78.5% of 487,000 = 382,295, say 382,000 cu in. Volume in cubic feet = 382,000 ÷ 1728 = 221 cu ft. Capacity in gallons = 382,000 ÷ 231 = 1650 gal. Capacity in pounds = 382,000 x 0.36 = 137,000 lb.

How about the volume of a tank with dished or bumped ends? The capacity of bumped or dished head is 2/3 that of a cylinder of the same length and diameter. Thus to get the volume of such a tank, assume it to be a flat-ended cylindrical tank of a length equal to length of the cylindrical part plus 2/3 the length of each bumped head minus 2/3 the length of each dished head.

For example, the tank *A* in Fig. 3 has the same volume as tank *B*. For any tank with dished or bumped heads first reduce to the equivalent tank with flat heads. Make a dimensioned sketch to avoid confusion. Then figure the capacity of the equivalent flat-headed tank.

Problem (Fig. 3): A tank 72 in. in diameter has a full-diameter length of 110 in. and two bumped heads, each 12 in. deep. What is the equivalent flat-headed tank?

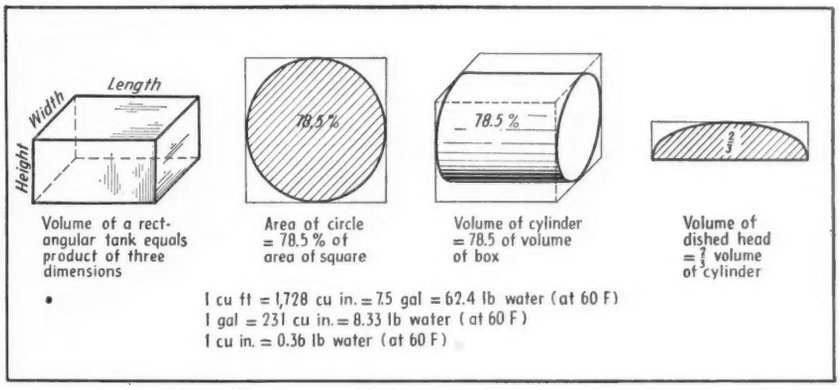


Bumped heads are equivalent to ⅔ same length of straight tank

Each 12-in. bumped head is equivalent to 2/3 x 12 = 8 in. of straight tank, so the equivalent flat-headed tank is 72 in. in diameter and has a length of 110 + 8 + 8 = 126 in. This figures 300 cu ft.

If the original tank had two dished heads, its equivalent length would be 110 — 8 — 8 = 94 in. If it had one bumped head and one dished head, its equivalent length would be 110 + 8 — 8, same as the original tank. In this case the bumped head would cancel the dished head.

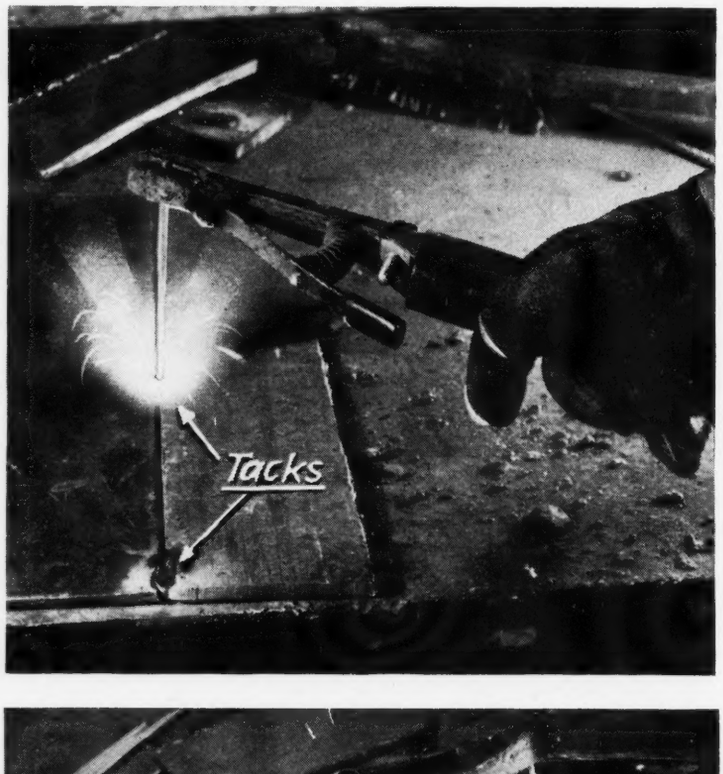
Note: In all computations of tank capacity use the inside tank dimensions, not the outside.


Length
Width
Height
78.5%
78.5%
Volume of a rectangular tank equals product of three dimensions
Area of circle = 78.5 % of area of square
Volume of cylinder = 78.5 of volume of box
Volume of dished head = ⅔ volume of cylinder
1 cu ft = 1,728 cu in. = 7.5 gal = 62.4 lb water (at 60 F)
1 gal = 231 cu in. = 8.33 lb water (at 60 F)
1 cu in. = 0.36 lb water (at 60 F)

HOW TO MAKE A SIMPLE BUTT WELD

(Prepared with the cooperation of the Lincoln Electric Co. Photos posed by POWER in Lincoln's New York demonstration room)

▶LAST MONTH (page 110) this section showed how to strike an arc and run a bead. Master that procedure before starting this exercise—making a simple butt weld joining mild steel plates not over $\frac{3}{16}$ in. thick.

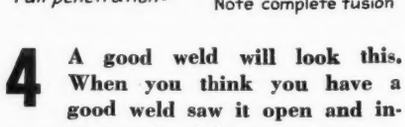


1 →

Get ready, as before — ground one terminal of machine to metal table, connect other to electrode holder, put ⅛- or 5/32-in. coated rod in holder. (See last month's comment on "polarity") Place plates on table with edges parallel and about ⅛ in. apart. Strike arc at one end of seam and "tack weld". Then same for other end. Before proceeding, inspect for uniform spacing of plates. If not uniform, break open and retack correctly

2 →

Starting at the near end, strike an arc and move rod slowly along center of gap until whole length is welded. Keep electrode nearly vertical and very close to pool of molten metal (about ⅛ in.). A steady "hissing" sound will indicate correct gap

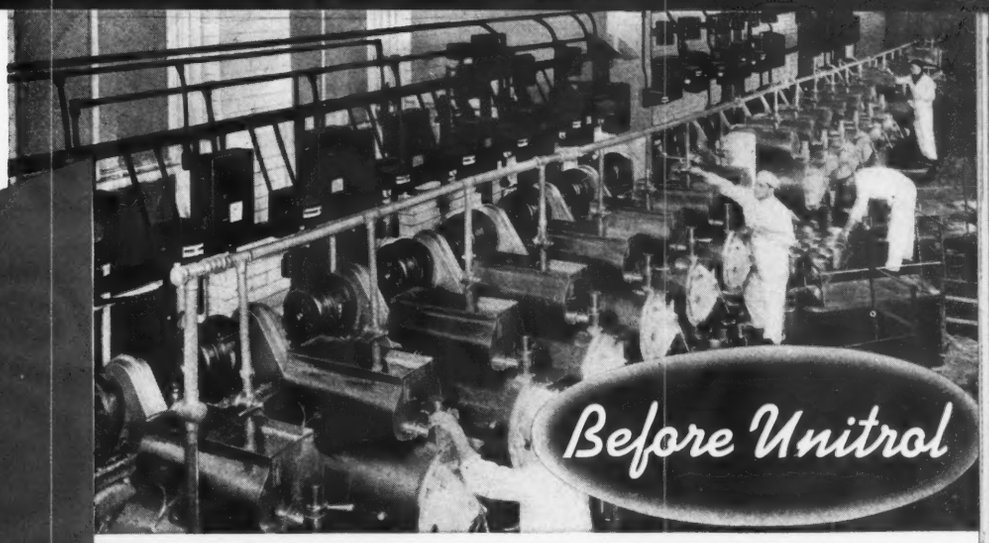


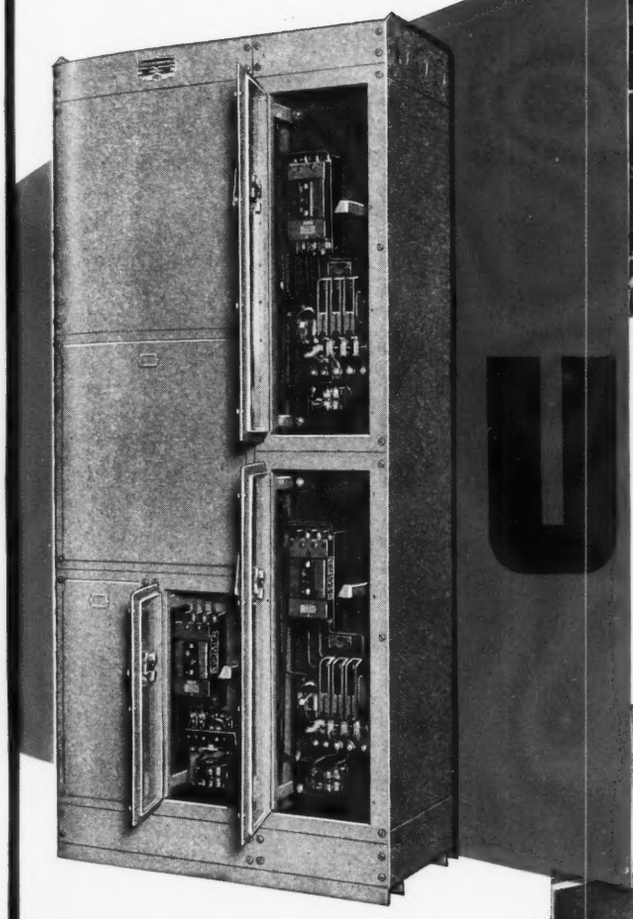
4 A good weld will look this. When you think you have a good weld saw it open and inspect section for defects.

← **3**

Move electrode straight, slowly and steadily. Don't let it get ahead of its pool of molten metal. Too much speed, or too little current, will cause lack of penetration. Too little speed, or too much current, will cause undercutting and burning through. Sketches show these, also overlap

NOTE: The method here shown (butt-welding unbeveled plates with a straightline movement of the electrode) should be used only for plates 3/16-in. thick or less. For any plate between ⅛ in. and 3/16 in. in thickness, it may be advisable to run the bead first on one side and then on the other. The third article in this arc-welding series (December POWER) will show how to butt-weld plates ¼ in. or thicker.





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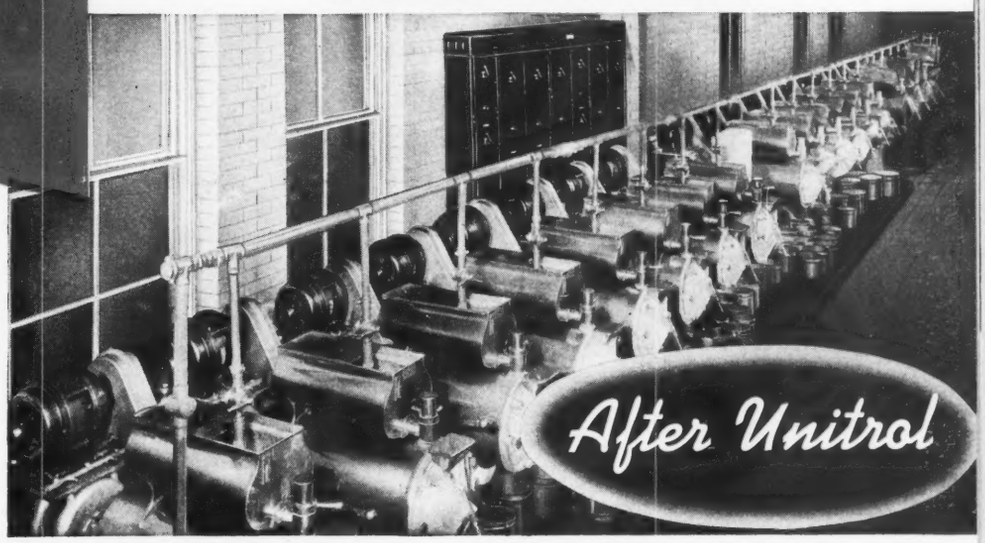

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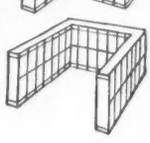

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Performance of Engine Driven Pumps

(Continued from page 85)

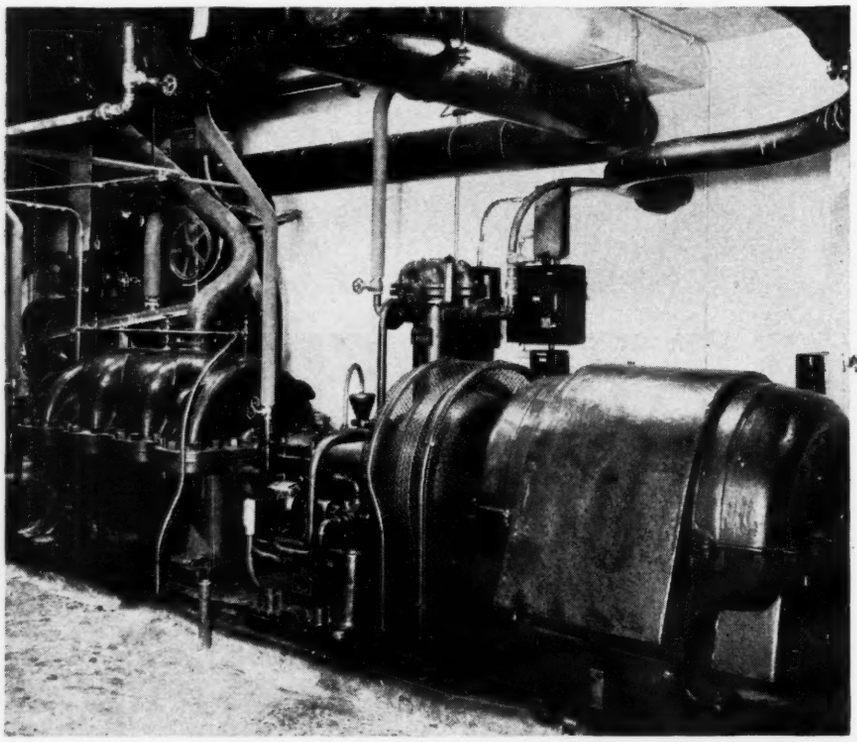

Fig. 5—Large centrifugal condensate pump driven by electric motor through hydraulic coupling to adjust speed of the pump to vary its capacity

rpm the pump required 42 hp. The engine can develop only 33 hp at 2000 rpm; thus, the pump must be throttled to bring its power input down to equal engine output.

When the pump is throttled and its power starts to decrease, the engine speeds up. Consequently, power required to drive the pump goes up. Since pump power rises more with speed than does engine power, a point is soon reached where pump and engine powers are equal and speed again becomes constant.

The accompanying table gives data necessary to determine pump performance at any given engine speed. Take the case where the pump has been throttled to increase engine speed to 2000 rpm. At this speed the engine will develop 33 hp, as shown in Fig. 3. This value is given in column No. 2, opposite 2000 rpm in the table. The speed ratio of 2000 to 1800 = 2000 ÷ 1800 = 1.11, which is given in column No. 3. Power to drive the pump increases as the cube of the speed and the cube of the speed ratio equals 1.37, as given in column 4. When the pump was driven by the motor in our previous problem, it was assumed that the motor had sufficient power to drive the pump at 4000 rpm; pump power increased from 30.5 hp to 30.5 × 1.37 = 42 hp. The engine, with wide-open throttle, can develop only 33 hp, all that is available to drive the pump at 4000 rpm. Obviously, this won't work.

To arrive at a head and capacity that can be stepped up according to the law governing pump performance and arrive at 33 hp pump load, first divide 33 hp by the speed ratio cubed, 33 ÷ 1.37 = 24 hp, given in Column 5. At 24 hp and 3600 rpm, Fig. 2, the pump will discharge 130 gpm against a head of 460 ft, see Columns 6 and 7. Under these conditions, pump efficiency is about 64%, Column 8. At 33 hp and 4000 rpm, pump capacity increases to 130 × 1.11 = 144.3 gpm and head is 460 × 1.23 = 566 ft, Columns 9 and 10.

By a similar process values have been worked out for engine speeds of 2000, 2200, 2400 and 1700 rpm corresponding to 4000, 4400, 4800 and 3400 rpm of the pump. From the figures given in Columns 8 and 9 of the table, the head-capacity curve of Fig. 4 has been plotted. The horsepower curve corresponds to values taken from the engine curve, Fig. 3, at the various speeds.

Pump Efficiency

In these calculations it has been assumed that pump efficiency at the several points does not change with speed. This is very closely true in practice if the speed change is not too great.

In Fig. 4 it is evident that the head-capacity curve for variable speed and full-engine horsepower is considerably steeper than for constant speed. This is true only when pump constant-speed horsepower increases with capacity, as in Fig. 2. For a propeller pump, where the power at constant speed decreases with increased capacity the head-capacity curve is much flatter at variable speed and full-engine power than at constant speed.

It should be remembered that in these calculations based on engine-horsepower curves supplied by engine manufacturers, the engine power can be affected by carburetor adjustment, quality of fuel, elevation at which the engine operates and other factors.

PUMP PERFORMANCE DATA

(Engine-driven pump, normally rated 225 gpm at 400-ft head, operates at different speeds)

				At Normal Speed			At Operating Speed			
Engine rpm	*Engine hp*	*Speed ratio to normal*	*Speed ratio cubed*	*Pump hp*	*Capacity gpm*	*Head, ft.*	*Efficiency, %*	*Capacity, gpm*	*Head, ft.*	*Pump rpm*
1	2	3	4	5	6	7	8	9	10	11
1800	30.5	1.0	1.0	30.5	225	400	75.0	225	400	3600
2000	33.0	1.11	1.37	24.0	130	460	64.0	144.3	566	4000
2200	34.0	1.22	1.82	18.65	65	480	41.6	79.4	715	4400
2400	35.0	1.33	2.35	14.7	20	480	13.0	27	850	4800
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Power Show, ASME Annual Meeting Set for First Week in December

▶ COMMANDING THE ATTENTION of all power engineers is the calendar of events scheduled for the first week in December in New York City. Officially designated as the 14th National Exposition of Power & Mechanical Engineering, the Power Show will be held that week in Grand Central Palace. Also scheduled for December 2–7 is the 61st Annual Meeting of the American Society of Mechanical Engineers, with headquarters at the Hotel Astor.

As evidence that interest in this year's Power Show is running well ahead of past performances, exhibition officials report that reservations for exhibit space are more than 5% over the previous show in 1938. With more than 270 leading manufacturers already having contracted for displays, the 1940 Show will be the most complete ever staged for the benefit of power men.

More than 40,000 engineers, executives and operating men are expected to visit the Power Show, coming from every state in the Union and several foreign countries. A breakdown of previous attendance records reflects the probable occupational distribution. It will be something like 30% engineers engaged in operation and maintenance of plants, a slightly smaller percentage of industrial and other general executives, upwards of 20% engineers engaged in process and production. Research men and engineers engaged in the design and construction of power plants will make up another 9 or 10% of the total registered attendance.

The Exposition will open at 2 p.m. Monday, December 2, and at 11 a.m. the rest of the week. Closing hour is 10 p.m. each night except Wednesday and Saturday nights, when closing time will be 6 p.m. Admission is by registration only; the show is not open to the general public.

Like all the National Power Shows since the first one in 1922, this 14th Exposition is being conducted by the Internation Exposition Co, Grand Central Palace, New York, N. Y. Charles F Roth is president.

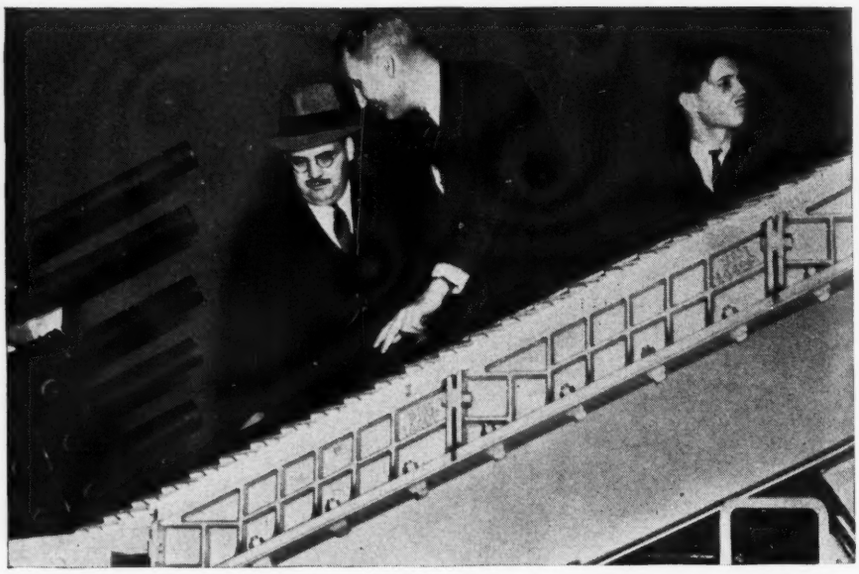
Among the papers and sessions of interest to power engineer to be presented at the ASME meeting are:

Monday, December 2

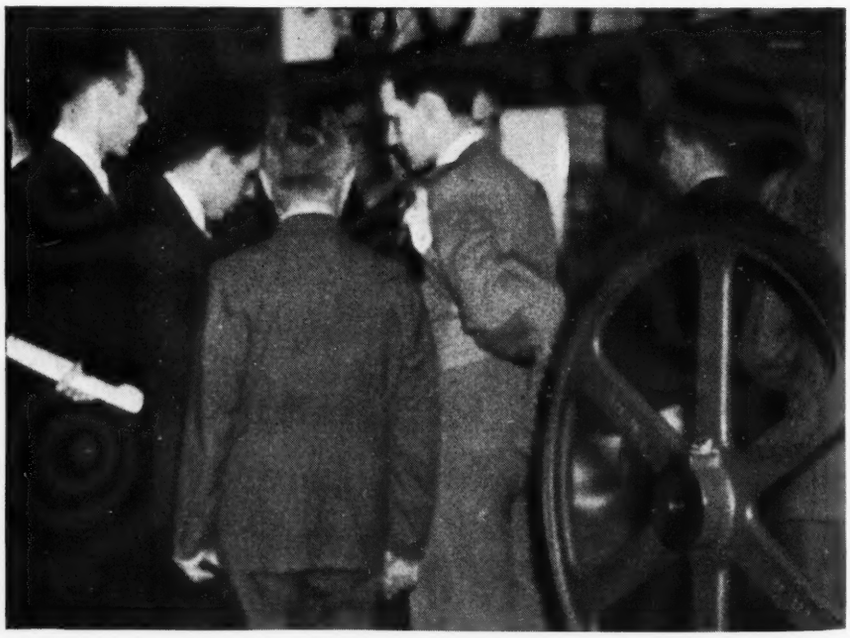
Fuels I—"New Data on Coal Ash in Boiler Furnaces," by E G Bailey, Babcock & Wilcox Co.

Machine-Shop Practice I—"Lubrication of General Electric Turbines," by C Dantsizen. "Lubrication Studies," V M Palmer and C Pope, Eastman Kodak.

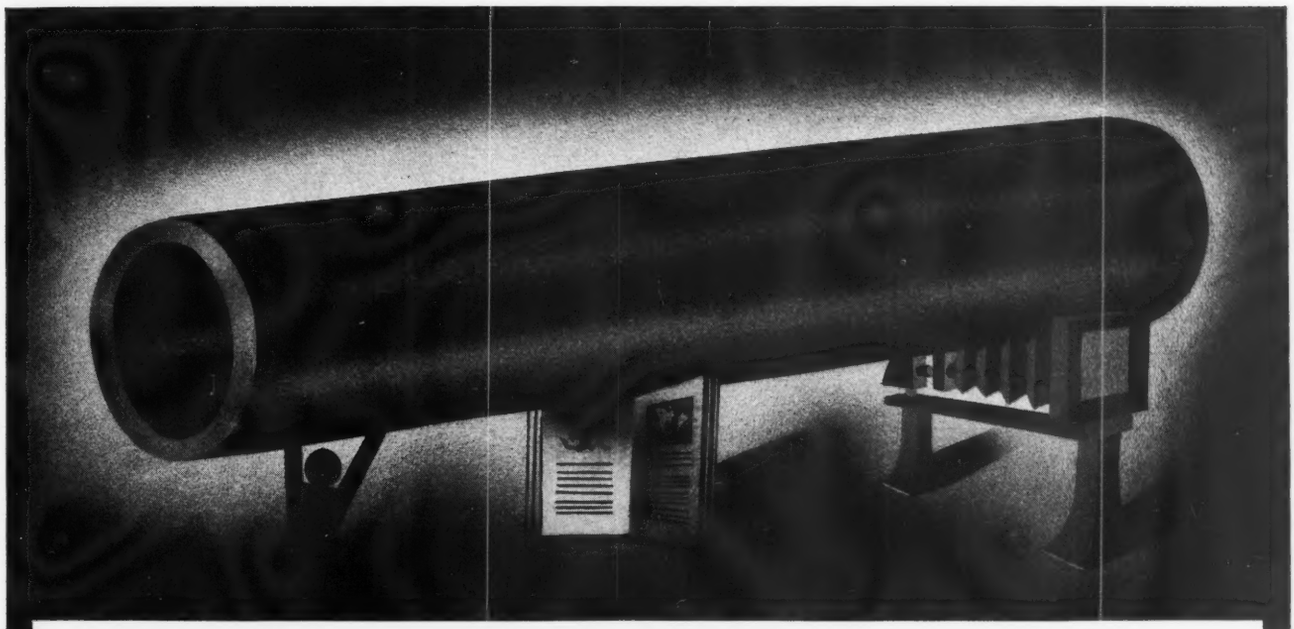
(*Continued on page 124*)



"If it's information on stokers you want, you came to the right place", says B T U Giver to John Q Power Engineer. Same show is put on every day for a week by manufacturers of boilers, turbines, meters, and a host of other power equipment



"Well, I'll be damned if it doesn't"



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Boiler-Feedwater Studies—"Silica" by Harold Farmer, chief chemist, Philadelphia Electric Co. "Silica Removal," by H L Tiger, vice-president, The Permutit Co. "Problem of Boiler Feedwater Treatment at New High-Pressure Installation at Waterside Station," by W E Caldwell, Consolidated Edison Co. "Absorption Process for Removal of Soluble Silica from Water," by L Drew Betz, Charles A Noll and John J Maguire, W H & L D Betz, Philadelphia.

Tuesday, December 3

Fuels II—"Continuous Heat Balance Control of Boiler-Room Operation," by B S Murphy, chief engineer, Hudson Ave Station, Brooklyn Edison Co. "Flow Processes in Underfeed Stokers," by Martin A Mayers, Carnegie Institute of Technology.

Power-Fuels—"Analysis of Flow in Tubes of Large Steam-Generating Units," by John Van Brunt, Combustion Engineering Co. "Some Particulars of Design and Operation of a Twin-Furnace Boiler," by John Blizard and A C Foster, Foster Wheeler Corp.

Oil and Gas Power—"Effects of Surface Finish on Journal Bearing Performance," by J T Burwell, Jr, Mass. Inst of Technology. "Elastic Shaft Couplings for Use with Internal-Combustion Engines," by J Ormondroyd, Univ of Michigan.

Industrial Instruments and Regulators—"Automatic Control of Surge Tanks"; "Combustion Explosions in Pressure Vessels Protected with Rupture Disks," by Merl D Creech, Black, Sivalls, & Bryson, Inc.

Wednesday, December 4

Power II—"A New Steam Engine and Boiler," by John I Yellott, Armour Inst of Technology, and S L G Knox, Bucyrus Co. "Steam Temperature Control Systems for Modern Steam Generators," by M H Kuhner, Riley Stoker Corp. "Determination of Steam Quality," by Frederick G Straub, and Elwood E Nelson, Univ of Illinois.

Dust Collection—"Pressure Loss Formulas for Centrifugal Dust Collection," by Marcel A Lissman and Franklin Miller, Western Precipitation Co. "Recent Experience in the Application of Wet-Type Dust Scrubbers," by A W Anthony, Jr, Pease-Anthony Equipment Co, and R V Kleinschmidt.

Lubrication II—"Power Losses in High-Speed Journal Bearings," by F C Linn and D E Irons, General Electric.

Power—Applied Mechanics—"A Mechanical Method for Solving Pipe Problems Involving Temperature Expansion," by F M Hill, Commonwealth & Southern Corp. "Condenser Tubes and Their Corrosion," by C W E Clarke, consulting engineer, and A E White, Univ of Mich. "Flow of Saturated Water Through Orifices," by M W Benjamin and J G Miller, Detroit Edison Co.

Fluid Meters—"The Annis Meter for Measuring Flow at the Intake End of Closed Conduits," by R K Annis, consulting pump designer and M B MacNeille, Fairbanks, Morse & Co. "Effect of Ambient Temperature on the Coefficients of Venturi," by W S Pardoe, Univ of Pennsylvania. "Discharge Coefficients of Long-Radius Flow Nozzles When Used with Pipe-Wall Pressure Taps," by H S Bean, National Bureau of Standards, S R Beitler, Ohio State Univ, and R E Sprenkle, Bailey Meter.

Thursday, December 5

Hydraulics I—"Mechanical and Hydraulic Features of the Wheeler, Pickwick Landing, Guntersville and Chickamauga Hydroelectric Projects of the TVA," by J F Roberts and George R Rich, TVA. "Input Measurements at the Safe Harbor Hydro Development," by J M Mousson, Safe Harbor Water Power Corp.

Hydraulics II—"The Development of the Automatic Adjustable Blade Type of Propeller Turbine," by R V Terry, Newport News Shipbuilding & Drydock Co. "Speed Regulation of Kaplan Turbines," by J D Scoville, S Morgan Smith Co.

ENGINEERS' BOOKSHELF

Power Plants

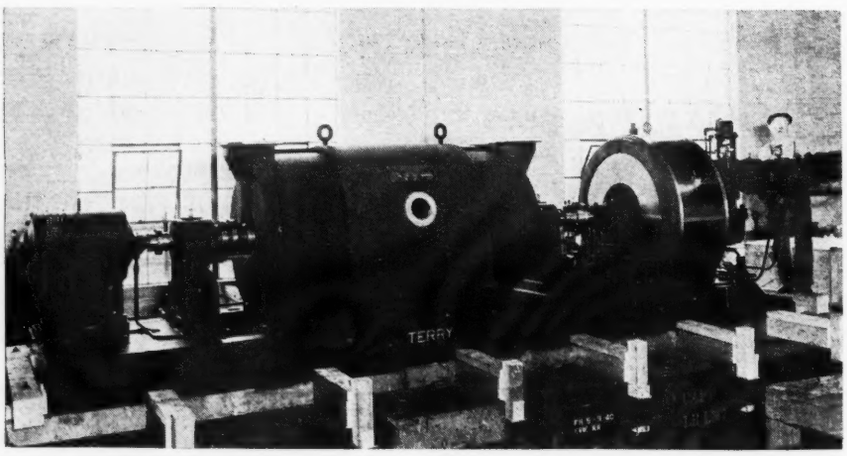
STEAM POWER STATIONS (2nd edition, 1940). *By Gustaf A Gaffert. Published by McGraw-Hill Book Co, 330 West 42nd St, New York, N. Y. 592 pages, 6x9 in., 379 illustrations, two folding charts. Price $4.50.*

This second edition of a well-known text contains new material, particularly on recent developments in high-pressure, high-temperature power plants. In general, the basic plan of the former edition is followed; the first half of the book covers specific types of equipment, such as engines, turbines, steam generators, etc, and specific problems such as feedwater treatment, fuels, etc.

The second half of the book is devoted to the economic and engineering aspects of station design. Chapters on power-plant equipment discuss theory of operation, construction, and performance, and give typical data on size, weight, cost, etc. Latter chapters present data on steam-station costs and economies, a discussion of the technique of economic analysis involved in equipment selection, and choice

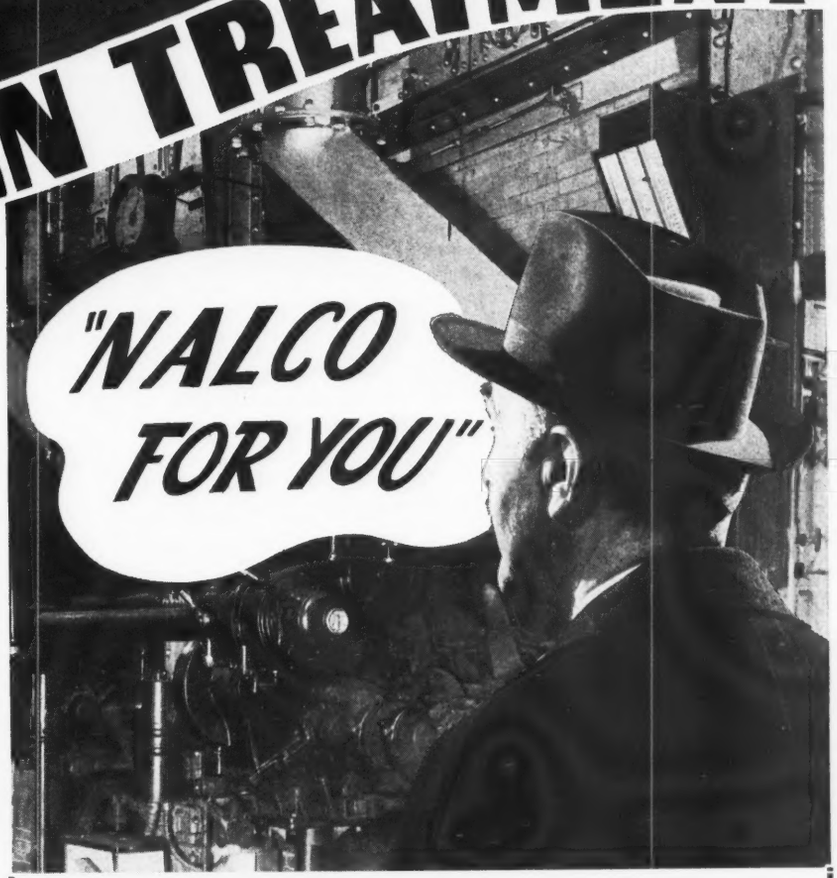
(Continued on page 142)

QUICK START FOR GLENDALE



1500-kw quick-starting Terry turbine-generator unit just before starting long trip to the new municipal steam station at Glendale, Calif., from its home plant in Hartford, Conn. Steam conditions are 625 lb, 825 F at the turbine throttle. Starting of the unit is by pushbutton control which opens the valve in the main steam line; with oil pressure already built up, the turbine will come up to full speed in less than 20 seconds. In case of low system frequency or power interruption, this turbine-generator will carry the auxiliary load

MODERN TREATMENT



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Without obligating me in any way, please have a Nalco engineer survey our plant and tell me in what way the Nalco system would benefit my company.

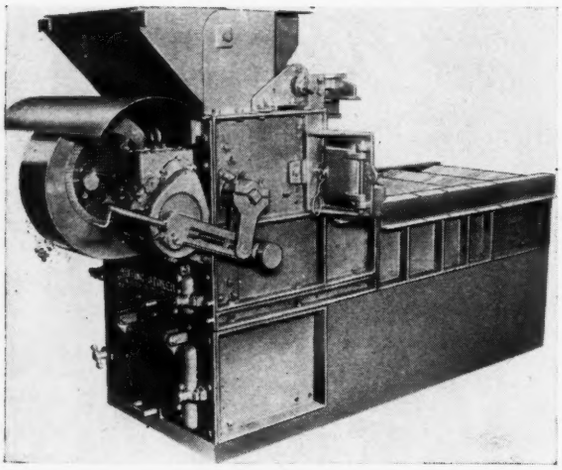
My name is.....Title.....

Company name .....

City ..... State.....

Canadian inquiries should be sent to ALUMINATE CHEMICALS LTD., 372 Bay St., Toronto, Ont.

WHAT'S NEW IN PLANT EQUIPMENT



Stoker

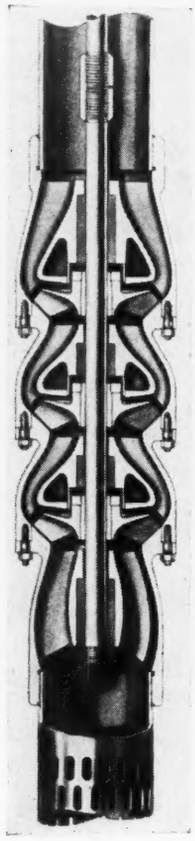
WHITING unit is adaptable to all coals from lignite to anthracite. Feed plate is combination section, forming the bottom of coal hopper as well as first of grate sections. Rear ends of these grate bars rest and slide upon a stationary grate. The second grate section in turn rests upon a third section, which is movable, and slides upon the fourth. Moving steps or grates have reciprocating motion which causes coal in hopper to progress uniformly across grate. Performance guarantee includes following points: (1) Smokeless operation to conform to local smoke ordinances, (2) capacity up to 50 lb of bituminous coal burned per hr per sq ft of active grate surface, (3) a CO_2 content of not less than 12% at center of gas stream through furnace exit or at end of flame shall be maintained when operating at or above a combustion rate of 15 lb per sq ft grate per hr, (4) combustible in ash shall not be more than 25% of weight of ash. Made in 2 types. Model A and low-set Model C, for capacities from 750 to 1650 lb coal burned per hr.

Whiting Corp, Harvey, Ill.

Hook-on Volt Ammeter

TYPE AK-1 hook-on volt ammeter, for measuring alternating current and voltage, can be operated by simply connecting two leads furnished with instrument, and then flipping thumb-manipulated switch to desired voltage position on scale. Alternating current can be read immediately by hooking instrument around line. Both insulated and non-insulated conductors may be read in this manner. Integral part of instrument is C-shaped, split-core current transformer so designed that it can be operated without a trigger. To make measurements, transformer is pulled open and placed against the conductor. Slight push on handle snaps transformer shut. Measurement completed, gentle pull springs open dovetail joint of transformer and releases conductor.

General Electric Co, Schenectady, N. Y.



Vertical Turbine Pumps

REDESIGNED line of 6-in. medium-capacity vertical turbine pumps now features newly designed impellers and seats. Available for a desired capacity of 100-gpm against 110-ft lift in a well, and 50-lb pressure above. New model requires 7½-hp motor, as against 10-hp for older model. Other advantages claimed by manufacturer include low operating costs, water-lubrication, with no stuffing box below ground level, and semi-open impeller adjusted from surface for wear and change of capacity. Pumps are non-sandlocking and non-gas-locking. Cross-section of pumping stages shows impellers and seats.

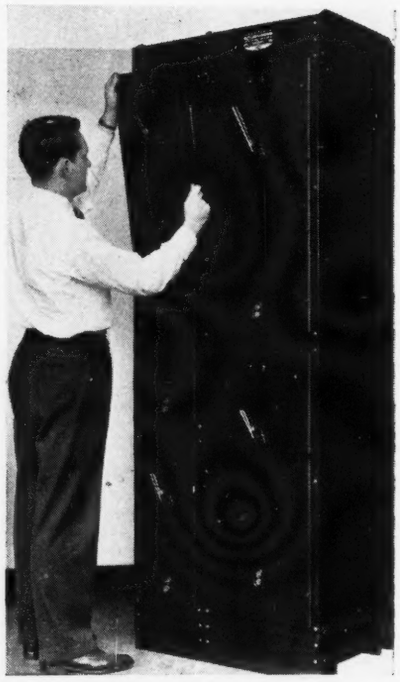
Pomona Pump Co, Pomona, Calif.

Sectionalized Motor Control

CUBICLES built on the same principle as modern sectional filing cabinets provide neat, safe enclosures for all usual motor-control devices. Standardized construction aids quick installation without detailed engineering layout. No supporting structure or building preparations are required; units are assembled with bus and wiring interconnections already made, or with provisions for wiring on the job as desired.

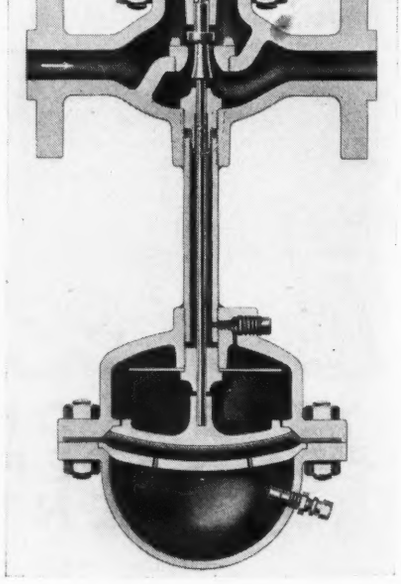
Future changes require solely replacing unit controllers or adding sections. 32 sizes include eight widths, four heights, for mounting any combination of controllers, disconnect switches and accessories. Control units can be mounted both front and rear for double-sided compactness. Descriptive booklet, available on request, gives dimensions, suggests many practical combinations and applications.

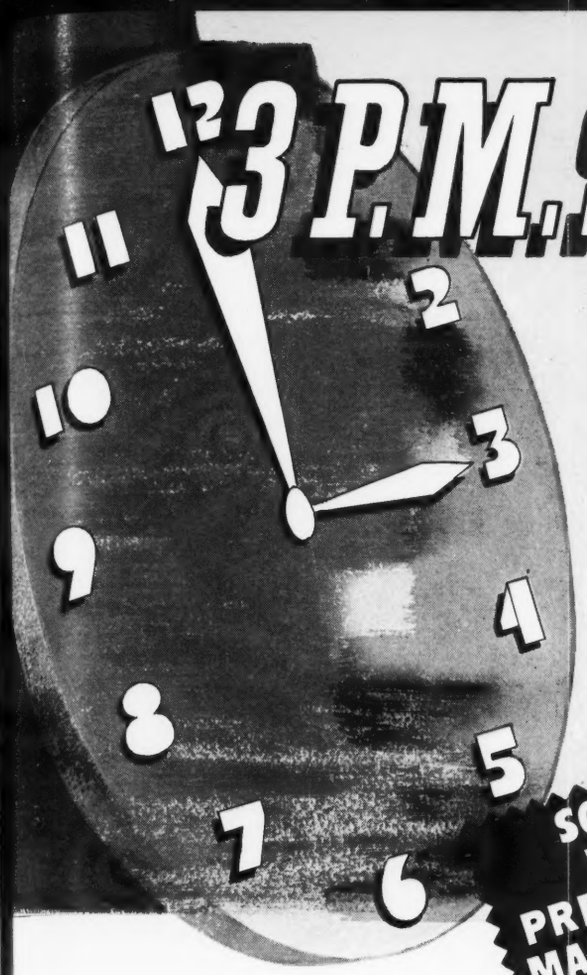
Cutler-Hammer, Inc, 1358 St Paul Ave, Milwaukee, Wis.



Pressure Regulators

FOSTER pressure-reducing regulator, Type 39-Q1, is single-seated, and built for initial pressures up to 2500 lb per sq in., and temperatures up to 1000 F. Can be adjusted for reduced pressures from 5 lb





3 P.M. SHUTDOWNS

A Case Where Too Much Steam Made Trouble

SOLVED WITH PREVENTIVE MAINTENANCE

"YOU'LL have to shut down at three today," the Superintendent of a northwestern wood-working plant said to his shop foreman. "... Kiln's tied up again with heating trouble. Something's got to be done about it!"

The plant was swamped with orders—like many another shop today. And repeated valve trouble in the steam line at the kiln meant falling farther behind on deliveries.

Ordinary repair of the valve, as was done before, had proved inadequate. Preventive Maintenance was the only answer. For it's the only way of keeping piping problems solved permanently. Yet, Preventive Maintenance is a simple technique—it's just a matter of *being sure* the installation is right, and the valves and fittings the best for the service conditions.

The Superintendent saw this clearly. That's why he called in H.E.O., the Crane Man. His wide experience would help to remedy the trouble quickly and surely.

Here's what the two men found: Steam was piped from the boiler with a four-inch line. The line was equipped with a four-inch pressure-reducing valve. And there was the source of the trouble! The valve was much too large. It couldn't operate properly at the low pressure setting required to heat the kiln. Severe wire-drawing cut the seat and disc—the valve leaked. The pressure went up and the kiln temperature couldn't be controlled.

The solution came quickly. Preventive Maintenance counseled replacement of the four-inch valve with a two-inch pressure regulator. It would give ample steam for heating the kiln. It would give finer control of the steam without restricting operation of the automatic valve mechanism. A Crane No. 960 brass regulator was put in the line.

Results: No more interruption of kiln operation; no more shop time lost for lack of material. Another plant superintendent knows the value of Preventive Maintenance. Also knows the Crane Man can help him get most for piping maintenance dollars. Because Crane is not only the source of valves and fittings for every service, but of accurate information on their proper application as well.

This case is based on the personal experience of H.E.O., a Crane Representative in the St. Paul Branch.

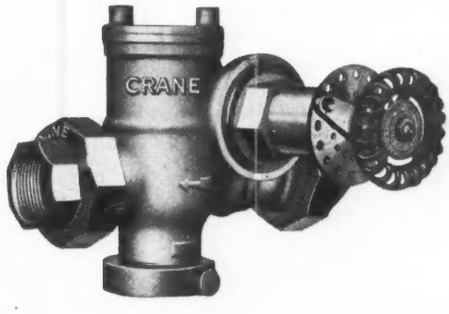
REDUCED PRESSURES KEPT AT STEADY FLOW WITH CRANE 960's

Cutting down pressure is only part of the job of pressure reducing. What you also want is a steady flow in the service line. You get both in these sturdy-built Crane No. 960 Brass Pressure Regulators for steam or air.

The 960 is ideal for Preventive Maintenance on modern process lines—on vulcanizers, cookers, driers, paper machines, air tools, air blasts, in heating systems.

Unlike ordinary reducing valves, the Crane 960 maintains reduced pressure at the point desired regardless of how much steam or air is being used. It will not permit pressure build-up when service line is idle.

Crane 960's are available for reduced pressure ranges of 5 to 30 pounds and 31 to 200 pounds. Operation is simple; ready accessibility permits easy inspection and servicing. In 6 sizes up to 2". Page 415 of your Crane No. 52 Catalog gives complete specifications.



1940 our 85th YEAR

CRANE

CRANE CO., GENERAL OFFICES: 836 S. MICHIGAN AVE., CHICAGO

VALVES • FITTINGS • PIPE
PLUMBING • HEATING • PUMPS

NATION-WIDE SERVICE THROUGH BRANCHES AND WHOLESALERS IN ALL MARKETS

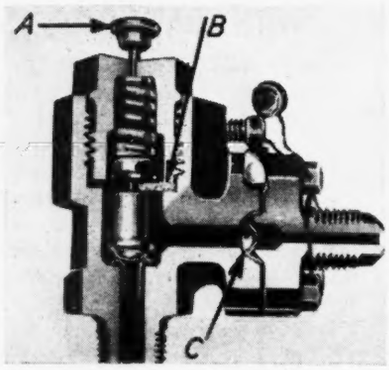
Inspect Crane Products at the Power Show — Booth 53 — Grand Central Palace, New York — December 2 to 7

to up to within a few pounds of initial pressure simply by changing dome load. Unit has no operating springs, and no stuffing box. Constant loading is imposed by air, thereby insuring constant regulation. Accuracy is said to be unaffected by spring deflection and hysteresis. All parts accessible and renewable without removing body from line. Pressure regulated by valve can be adjusted at distant control point conveniently located by installation of an extension loading tubing for hand pumping or by pilot control valve where air supply is available.

Foster Engineering Co, 109 Monroe St, Newark, N. J.

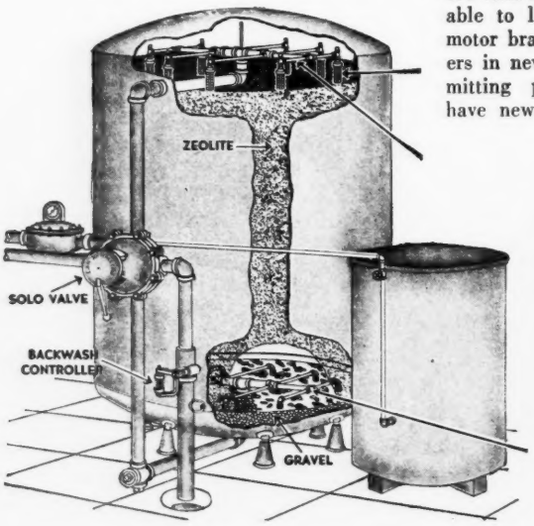
Relief Valve

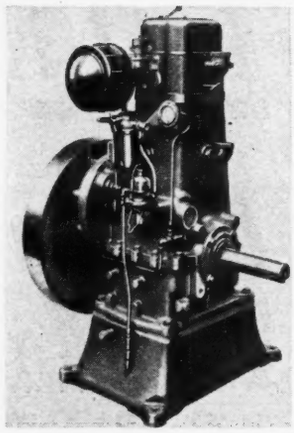
SAFETY-HEAD relief valve has setting slightly above working pressure of vessel on which unit is installed. After unit is installed on pressure system, slight lift on button, *A*, opens relief valve, which is then held open by gas pressure on actuating diaphragm *B* until rupture disk *C* is burst by emergency over-pressure. This



removes pressure from actuating diaphragm *B* and valve becomes an ordinary spring pop valve, closing when emergency is past, and pressure has dropped to normal. Spring relief valve then holds gas in system with minimum of leakage, and new rupture disk may be installed at operator's convenience without shutting down equipment.

Black, Sivalls & Bryson, Inc, Kansas City, Mo.





Diesel Engines

ENGINES said to develop more power per cubic displacement and to be smoother running and more economical to operate. 7½ and 10-hp models are single cylinder. 15 and 20-hp are twin-cylinder type. Illustration shows standard stationary mounting. Bulletin 51.

Stover Mfg & Engine Co, Freeport, Ill.

Strainer System

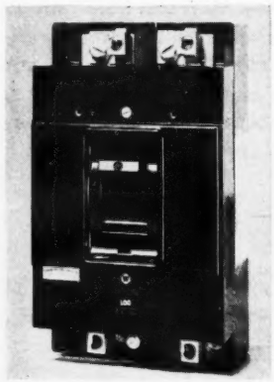
(below, left)

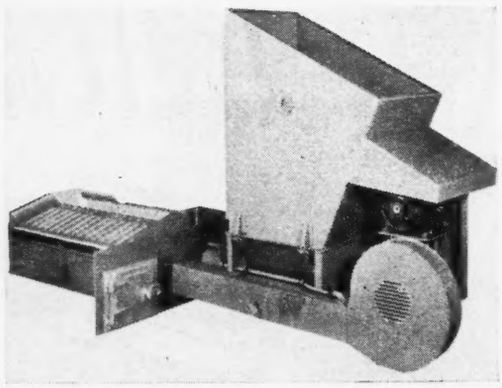
DOUBLE-CHECK STRAINER SYSTEM to prevent loss of zeolite, obtains better water distribution, increases capacity of water softener and permits use of larger amount of zeolite in a softener of given size. Lower check valve is closed by flow of water from manifold, so that water cannot pass through strainer, leaving through open check valve and spraying evenly over zeolite bed. Slotted strainers in lower manifold permit free flow of water to service line, yet prevent escape of zeolite material.

Elgin Softener Corp, Elgin, Ill.

Circuit Breakers

GENERAL UTILITY CIRCUIT BREAKER for enclosure, panelboard or switchboard mounting is rated from 50 to 100 amp at 25 and 600 volts ac, 125, 250, volts dc, and is adaptable to lighting and feeder circuits and motor branch-circuit protection. All breakers in new series use 100-amp frame, permitting physical interchangeability, and have new magnetic trip. This is said to





permit very close setting of breaker for any tripping current from 3½ to 11 times breaker's normal rated current, and enables trip to be set under actual service conditions to give maximum protection.

Westinghouse Electric & Mfg Co, East Pittsburgh, Pa.

Anthracite Stoker

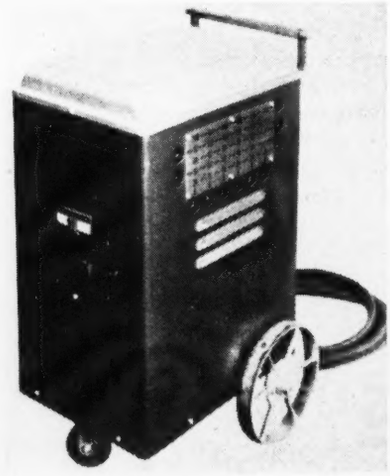
(above)

IRON FIREMAN Series 35 commercial anthracite stoker is designed for high- and low-pressure steam boilers, hot water boilers, and for industrial applications. Nine sizes available, for loads ranging from 25 to 1500 boiler horsepower. Coal is burned on inclined reciprocating grates which gradually move burning coal from retort toward ash pit. Air for combustion is supplied by a forced-draft fan through air ports in grate bars which are graduated so that coal is burned at a uniform rate and is finally consumed just before it spills into ash pit. Electric controls regulate stoker in accordance with load requirements.

Iron Fireman Mfg Co, 3295 West 106th St, Cleveland, Ohio.

Arc Welder

PORTABLE arc welder provides from 20 to 250 amps of welding current, available in 27 current steps. Current adjustment is accomplished by selecting current desired and inserting bayonet plugs into proper receptacles. Built-in "De-Ion" breaker insures protection against long sustained



POWER *at a Profit*

WITH

DE LA VERGNE

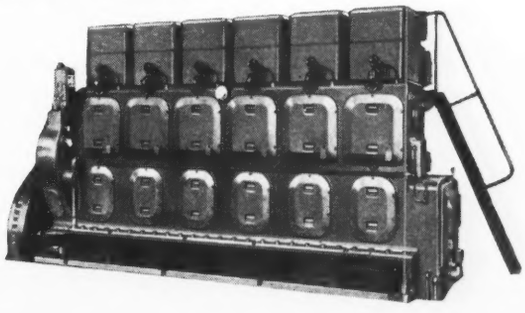
DIESEL ENGINES

"It doesn't cost us to generate current—it pays us," says Mr. F. R. Daly, Chief Engineer of the Minneapolis Chamber of Commerce Building. "Including an unusual foundation cost of $17,000 our De La Vergne installation is paying an annual return of 20% on the total investment."

This economy record, plus the quietness and dependability of the engine, made a De La Vergne diesel the logical choice when a second engine was recently installed to furnish additional power.

Why not investigate the money-saving possibilities in your own plant?

Baldwin De La Vergne Sales Corp., subsidiary of The Baldwin Locomotive Works, Phila.; Pacific Coast Representative, The Pelton Water Wheel Co., San Francisco.



BLW THE BALDWIN GROUP

BALDWIN DE LA VERGNE SALES CORP.

Subsidiary of THE BALDWIN LOCOMOTIVE WORKS

PHILADELPHIA

overloads, such as might occur if machine were accidentally left short-circuited. Welder is self-containd, enclosed in steel case mounted on three wheels.

Westinghouse Electric & Mfg Co, East Pittsburgh, Pa.

Boiler

HI-TEST boiler operates at 125 and 150 lb pressure, and can be fired with any fuels, either liquid, solid, or gas; hand or mechanical-fired. All joints are fusion welded, X-ray checked, and test-specimens recorded. Shells and head are fabricated from firebox and flange steel, 55,000 to 65,000 psi tensile strength. Internal stresses taken up without excess weight due to cylindrical shape with no stay bolts or cross braces. Has Cop-r-loy tubes as standard equipment. Tube layout provides for free unrestricted water circulation sweeping steam bubbles from heat transmitting surfaces so a steady water line is maintained. All tubes can be cleaned or removed from either front or rear of boiler.

Kewanee Boiler Corp, Kewanee, Ill.

Midget Wrenches

DESIGNED for speeding up jobs where small nuts and bolts have to be worked on, miniature wrenches have openings of $\frac{1}{4}$, $\frac{9}{32}$, $\frac{5}{16}$, and $\frac{11}{32}$ in. Each wrench has an open end and Boxocket end of same size.

Snap-on Tools Corp, Kenosha, Wis.

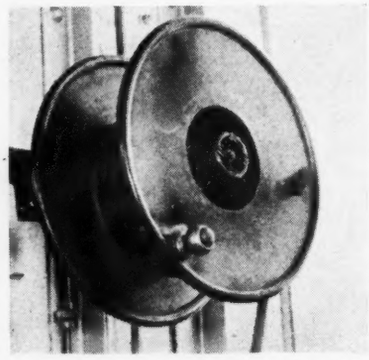
Underfeed Stoker

C-E LOW-RAM stoker unit has been designed to burn either coking or non-coking bituminous coals. Unit is low-set, electrically-driven with stationary grate bars and cantilever-type dump grates, body of stoker being only 16 in. high. Forced-draft fan, fitted with vortex-type inlet damper, and direct-connected to stoker-drive motor is integral part of unit. Main ram feeds coal from hopper to 1-piece retort extending full length of furnace section; and rear of retort, although supported by rear end frame, is free to float to allow for expansion. Adjustable auxiliary pushers, designed to distribute coal evenly from front to rear of retort, are bolted directly to auxiliary pusher bar which extends full length of retort.

Combustion Engineering Co, 203 Madison Ave, New York, N. Y.

Air Hose Reel

DEVELOPED for use with portable and stationary air compressors, units are made so that three feet, or entire 50 ft, of hose can be pulled from reel and valve then opened, allowing air to enter. Valve is self-



sealing, with no adjustments or packing, no stuffing boxes. Reels can be obtained in two styles. One has flat sides for wall mounting and for concave air tanks; other has one flat side and one concave side to fit over convex-end air tanks.

Schramm, Inc, West Chester, Pa.

Steam Trap

INDIRECT type consists of small standard Sarco inverted bucket trap coupled to diaphragm in condensate-discharge line. Trap acts as pilot. Large valve is normally closed but opened by trap when condensate opens trap valve, thus putting line pressure under diaphragm of main discharge valve. Main valve is full bore, single-seated and tight closing. It remains open as long as enough condensate reaches small pilot trap to keep its valve open.

Sarco Co, 183 Madison Ave, New York, N. Y.

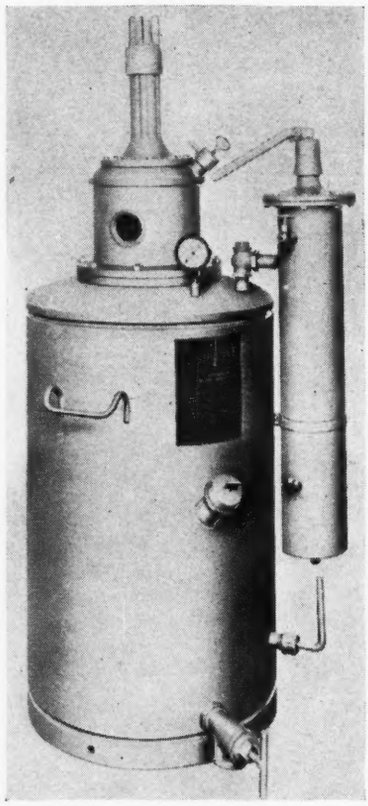
Speed Transmission (below)

ALL-SPEED V-belt variable-speed transmission has speed selector which operates on variable pulley principle. This selector consists of two interlocking pulleys mounted on common shaft. Variable-speed spindle can be pivoted laterally between motor and driven machine to provide new running diameters on interlocking pulleys. Selected speed is maintained by means of a lock nut on control quadrant.

Standard Transmission Equipment Co, 416 W 8th St, Los Angeles, Calif.

Acetylene Generator

PORTABLE unit is filled by loosening four wing nuts, lifting hopper from generator and placing it bottom side up on floor. Carbide is then added through hole provided. Twelve gallons of water, one gallon to every pound of carbide, are placed



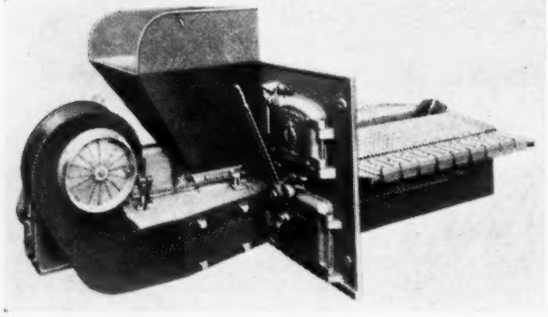
in main tank. Hopper can then be replaced and tightened down, and generator is ready for use. Charging is begun by merely lifting handwheel at top of hopper. Charging rate can be adjusted by turning handwheel right or left, depending on pressure desired. Generator is automatic thereafter.

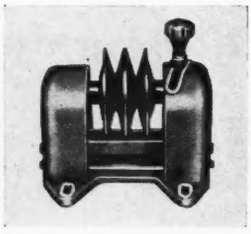
Marquette Mfg Co, Minneapolis, Minn.

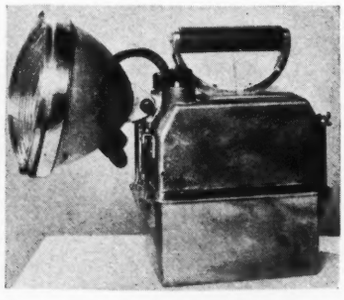
Emergency Lamp

MODEL SB 100 is a light for locations where no electric current is available or where hazardous atmosphere exists in regard to long power extensions. All joints between parts of battery case, lamp and lens holder, case and cord of unit are sealed, and together with vapor-proof switch, are said to insure positive protection of ex-

(Continued on page 150)





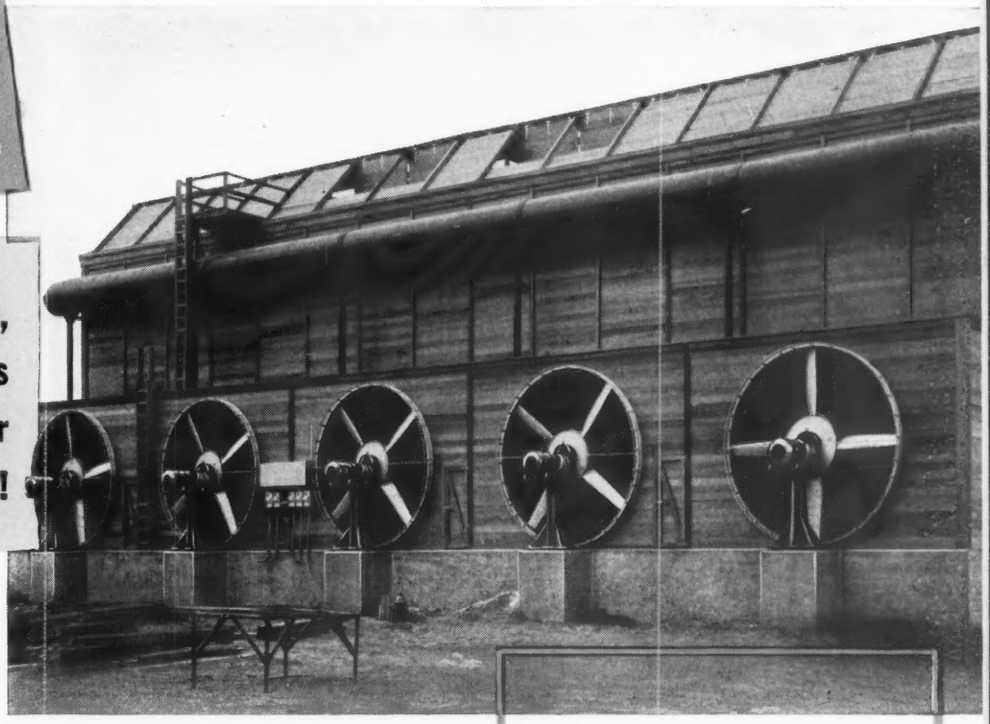


MAKES A CYCLONE

WITH ALLIS-CHALMERS MOTORS!

Another true case history from the Allis-Chalmers files that proves **"IT PAYS TO BUY THE EQUIPMENT THAT PAYS FOR ITSELF!"**

Panhandle Power & Light Company, Borger, Texas, Finds Allis-Chalmers Lo-Maintenance Motors the Answer to a Tough Operating Problem!



MAKING a man-made cyclone to cool 15,000 gallons of water per minute is a job in itself . . .

But when it has to be done outdoors in all kinds of Texas Panhandle weather — in heat . . . in rain and dust storms . . . then you've got a situation that calls for motors that are *better* than ordinary.

Recently when the Panhandle Power & Light Company put in a Foster Wheeler cooling tower at Borger, Texas, they knew they were up against a tough operating problem. Here's how they solved it —

They went to their own customers in the carbon black industry where motor conditions were notoriously severe . . . found *one* motor in general use. And that motor, they discovered, to be the Allis-Chalmers dust-proof, weather-proof Lo-Maintenance Motor!

That's why they selected these same motors . . . why today they can snap their fingers at all the hazards of outdoor motor service in the Texas Panhandle. And best of all — they know they'll continue to get low-cost, dependable service for many years to come.

THE PANHANDLE POWER & LIGHT Company heard amazing stories from their customers about the performance of Allis-Chalmers Lo-Maintenance Motors. That's why they chose these same motors to power the four-bladed axial flow fans in their new cooling tower . . . where 15,000 gallons of water per minute are cooled from 105° to 90°F.

Cut Your Power Costs With Lo-Maintenance Motors!

For Allis-Chalmers Lo-Maintenance Motors are built with extra-value construction to give performance that's more than just their nameplate ratings. These motors are outstanding in having high carbon steel frame . . . indestructible rotor . . . distortionless stator . . . plus Allis-Chalmers famous no-stint policy in materials and workmanship!

Whether you have difficult or easy motor jobs, it will pay you to use Lo-Maintenance Motors. The trained engineer in the district office near you will be glad to tell you how you can cut power costs. Call him today. Or write Allis-Chalmers, Milwaukee.

A 1287

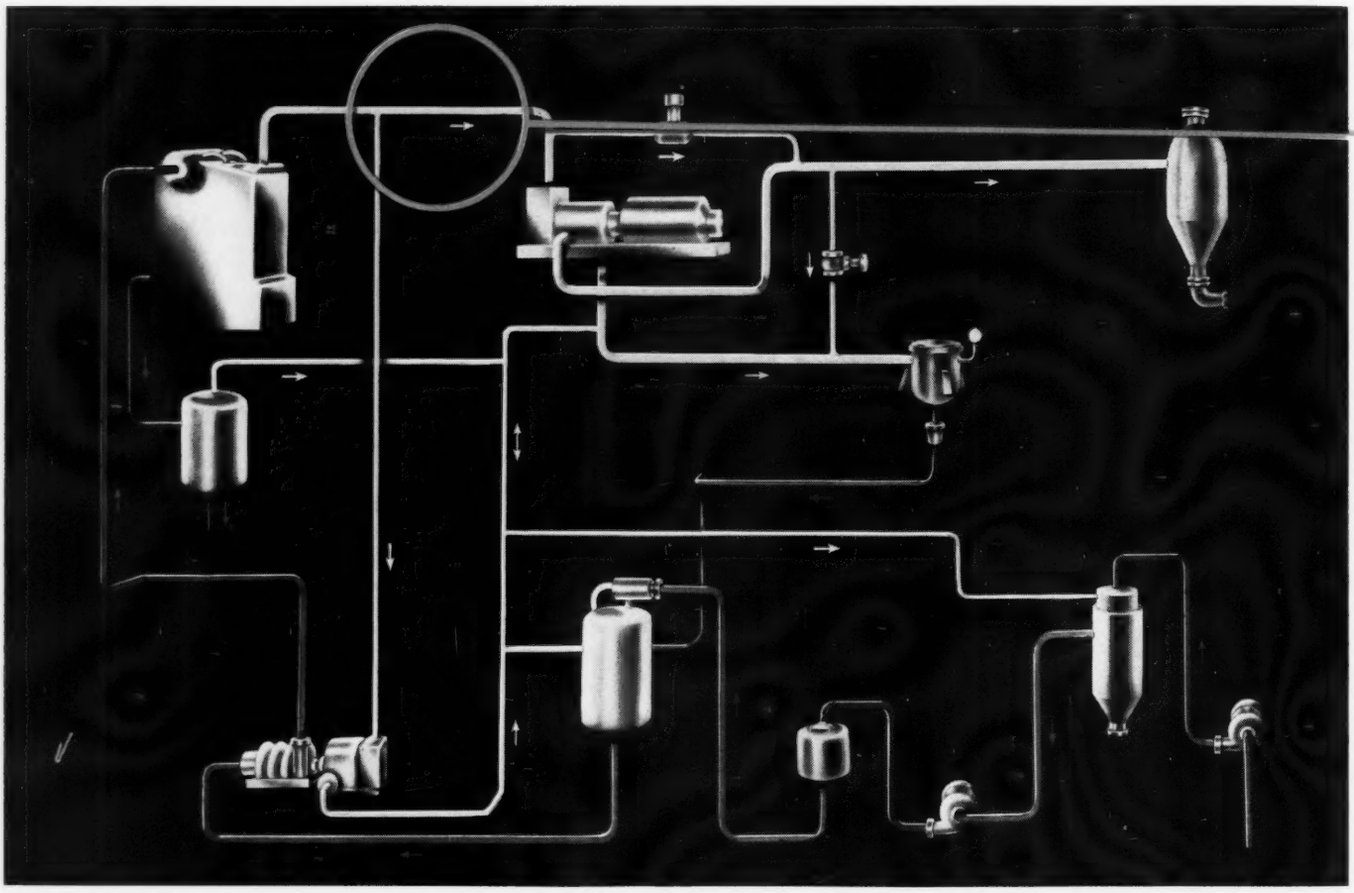
Over 90 Years of Engineering Superiority Work for You When You Specify Allis-Chalmers!

ALLIS-CHALMERS

MILWAUKEE · WISCONSIN

FROM *GOOD* POWER HOOKUPS

FOR STEAM DRAIN CONNECTIONS . . .



Courtesy—Power Magazine

HOOKUP #24 **In this chemical plant, power needs are small compared to steam demands; a backpressure turbine with bleed point makes low-cost by-product power and supplies steam for process at two pressure levels. Reducing valves insure steam supply in event of turbine outage. Main steam lines should be provided with drain connections for starting up and to guard against water pockets or slugs of carryover.**

SIMPLEST arrangement, shown in the top diagram opposite, is to trap drains back to a convenient heater, recovering most of the heat and all of the water. An orifice may be used in place of the trap.

In the second diagram, a receiver built to withstand full steam-line pressure collects drainage from several points and provides storage for slugs of water which would otherwise require a trap of large capacity. A small trap or orifice handles discharge from condensate receiver to any convenient heater.

To simplify handling drips and drains at different pressures and temperatures, from various parts of the plant, drainage can be passed through traps or orifices to a flash tank as shown in the third diagram. Flash steam goes to heater and water is pumped into feed circuit; this avoids dumping large quantities of water into the heater.

NEXT MONTH—2 PIPE HEATING SYSTEMS

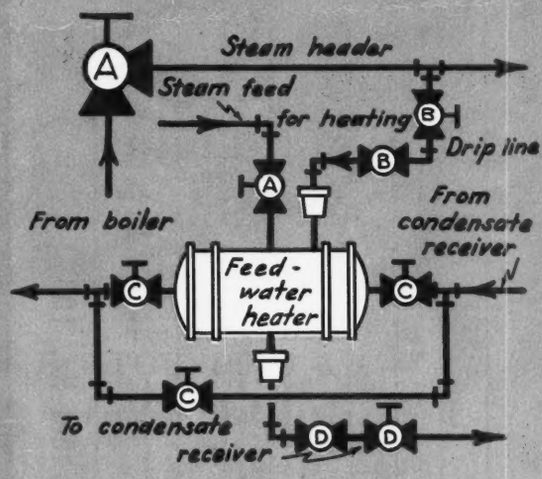
IN VALVES *Jenkins* GIVES YOU EVERYTHING

. . . TO *GOOD* VALVE PRACTICE

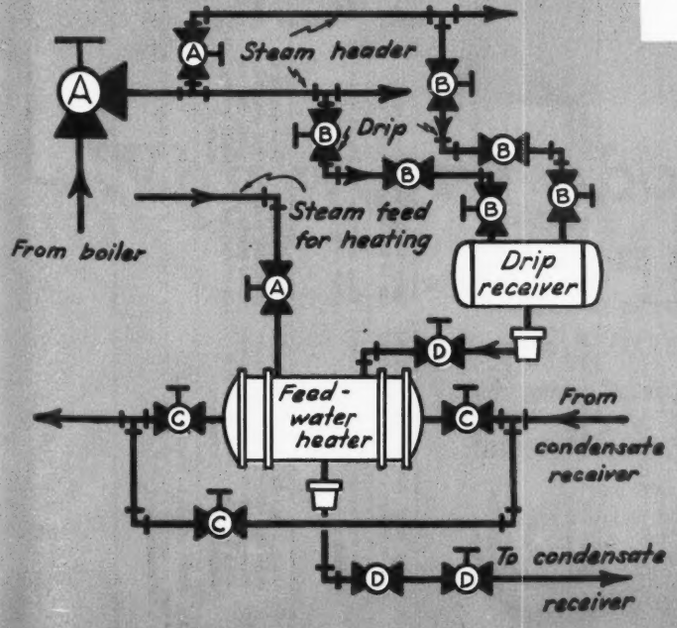
Jenkins RECOMMENDS . . .

RETURNING DRIPS FROM MAIN STEAM LINES

Drips direct to Heater



Drips to Receiver

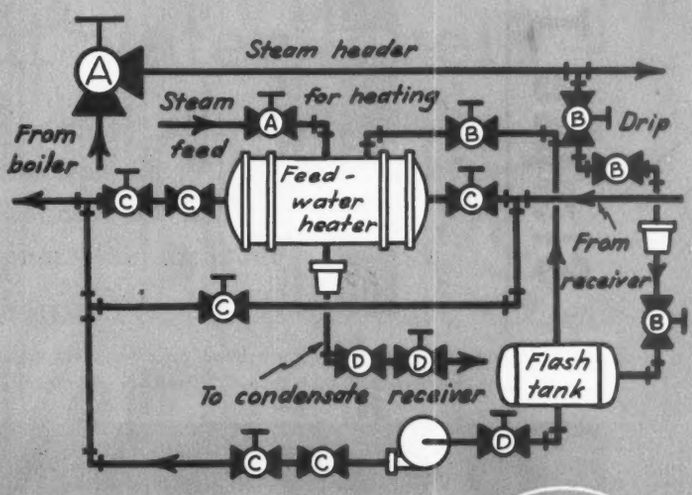


REFERENCE CHART TO JENKINS FIGURE NUMBERS FOR STEAM DRAIN CONNECTIONS

		100 lbs. S.P.	Up to 200 lbs. S.P.	Up to 300 lbs. S.P.	Up to 400 lbs. S.P.	Up to 600 lbs. S.P.
A	STEAM HEADER GLOBE	IRON* 142 Fl. Disc Type 613 Fl. Regrinding 913 Fl. Regrinding	IRON 162 Fl. Disc Type 923 Fl. Regrinding STEEL 1042 Fl. 30 Series	STEEL 1042 Fl. 30 Series	STEEL 1044 Fl. 40 Series	STEEL 1046 Fl. 60 Series
	ANGLE	IRON 144 Fl. Disc Type 615 Fl. Regrinding 915 Fl. Regrinding	IRON 163 Fl. Disc Type 925 Fl. Regrinding STEEL 1043 Fl. 30 Series	STEEL 1043 Fl. 30 Series	STEEL 1045 Fl. 40 Series	STEEL 1047 Fl. 60 Series
	GATE	IRON 651 Fl. O.S. & Y.	IRON 204 Fl. O.S. & Y. STEEL 1010 Fl. 30 Series	STEEL 1010 Fl. 30 Series	STEEL 1011 Fl. 40 Series	STEEL 1012 Fl. 60 Series
B	DRIP LINES GLOBE	BRONZE 106A Sc. Disc Type 750 Sc. Regrinding 950 Sc. Regr-Renew 956 Sc. Regr-Renew Plug Type	BRONZE 801 Sc. Disc Type 1140 Sc. Regrinding 1150 Sc. Regr-Renew	BRONZE 970 Sc. Regr.-Renew 976 Sc. Regr.-Renew Plug Type		
	GATE	BRONZE 47 Sc. Trav. Spind. 370 Sc. Non-Rising	BRONZE 270 Sc. Non-Rising	BRONZE 280 Sc. Non-Rising		
	SWING CHECK	BRONZE 352 Sc. Disc Type 353 Fl. Disc Type 762 Sc. Regrinding 763 Fl. Regrinding	BRONZE 262 Fl. Disc Type 963 Fl. Regrinding 260 Sc. Disc Type 962 Sc. Regrinding	BRONZE 260 Sc. Disc Type 962 Sc. Regrinding		
C	FEED LINES GLOBE	BRONZE 106A Sc. Disc Type 750 Sc. Regrinding 950 Sc. Regr.-Renew 956 Sc. Regr.-Renew Plug Type IRON 613 Fl. Regrinding 913 Fl. Regrinding	BRONZE 801 Sc. Disc Type 1140 Sc. Regrinding 1150 Sc. Regr-Renew IRON 923 Fl. Regrinding	BRONZE 970 Sc. Regr.-Renew 976 Sc. Regr.-Renew Plug Type		
	SWING CHECK	BRONZE 352 Sc. Disc Type 762 Sc. Regrinding	BRONZE 260 Sc. Disc Type	BRONZE 962 Sc. Regrinding		
	GATE	BRONZE 47 Sc. Travel. Spind. 370 Sc. Non-Rising IRON 325 Sc. Non-Rising 326 Fl. Non-Rising 650 Sc. O.S. & Y. 651 Fl. O.S. & Y.	BRONZE 270 Sc. Non-Rising IRON 251 Sc. Non-Rising 255 Fl. Non-Rising 277 Sc. O.S. & Y. 253 Fl. O.S. & Y.	BRONZE 280 Sc. Non-Rising IRON 203A Sc. Non-Rising 203 Fl. Non-Rising 204A Sc. O.S. & Y. 204 Fl. O.S. & Y.		
D	DRAIN AND EXHAUST GLOBE	BRONZE 106A Sc. Disc Type 750 Sc. Regrinding 950 Sc. Regr.-Renew 956 Sc. Regr.-Renew Plug Type IRON 142 Fl. Disc Type 613 Fl. Regrinding 913 Fl. Regrinding	BRONZE 801 Sc. Disc Type 1140 Sc. Regrinding 1150 Sc. Regr.-Renew IRON 162 Fl. Disc Type 923 Fl. Regrinding	BRONZE 970 Sc. Regr.-Renew 976 Sc. Regr.-Renew Plug Type		
	GATE	Same as "C" above	Same as "C" above	Same as "C" above		
	SWING CHECK	BRONZE 352 Sc. Disc Type 762 Sc. Regrinding IRON 623 Sc. Regrinding 624 Fl. Regrinding 294 Sc. Disc Type 295 Fl. Disc Type	BRONZE 762 Sc. Regrinding IRON 338 Sc. Disc Type 339 Fl. Disc Type	BRONZE 962 Sc. Regrinding IRON 338 Sc. Disc Type 339 Fl. Disc Type		

Motor-Operated Iron and Steel Valves can be supplied. Cast Steel Valves with ends for welding can be supplied.

Drips to Flash Tank



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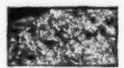
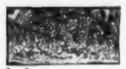
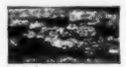
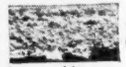
#24 OF A SERIES designed to help in your selection of JENKINS VALVES

Simple Tests for Identifying Metals

	WHITE CAST IRON	GRAY CAST IRON	MALLEABLE* IRON	WROUGHT IRON	LOW-CARBON STEEL AND CAST STEEL	HIGH-CARBON STEEL	ALLOY** STEEL	COPPER	BRASS AND BRONZE	ALUMINUM AND ALLOYS†	MONEL METAL	NICKEL	LEAD††
FRACTURE	Very fine silvery white silky crystalline formation	 dark gray	 dark gray	 bright gray	bright gray	very light gray	medium gray	red color	red to yellow	white	light gray	 almost white	white; crystalline
UNFINISHED SURFACE	Evidence of sand mold; dull gray	Evidence of sand mold; very dull gray	Evidence of sand mold; dull gray	Light gray; smooth	Dark gray; forging marks may be noticeable; cast — evidences of mold	Dark gray; rolling or forging lines may be noticeable	Dark gray; relatively rough; rolling or forging lines may be noticeable	Various degrees of reddish brown to green due to oxides; smooth	Various shades of green, brown, or yellow due to oxides; smooth	Evidences of mold or rolls; very light gray	Smooth; dark gray	Smooth; dark gray	Smooth; velvety; white to gray
NEWLY MACHINED SURFACE	Rarely machined	Fairly smooth; light gray	Smooth surface; light gray	Very smooth surface; light gray	Very smooth; bright gray	Very smooth; birght gray	Very smooth; bright gray	Bright copper red color dulls with time	Red through to whitish yellow; very smooth	Smooth; very white	Very smooth; light gray	Very smooth; white	Very smooth; white
APPEARANCE OF CHIP	Small broken fragments	Small partially broken chips	Chips do not break short as in cast iron	Smooth edges where cut	Smooth edges where cut	Fine grain fracture; edges lighter color than low-carbon steel	**	Smooth chips; saw edges where cut	Smooth chips; saw edges where cut	Smooth chips; saw edges where cut	Smooth edges	Smooth edges	Any shaped chip can be secured because of softness
SIZE OF CHIP		⅛ in.	¼-⅜ in.	Can be continuous if desired	Can be continuous if desired	Can be continuous if desired	**	Can be continuous if desired	Can be continuous if desired	Can be continuous if desired	Can be continuous if desired	Can be continuous if desired	Can be continuous if desired
FACILITY OF CHIPPING	Brittleness prevents chipping smooth groove	Not easy to chip because chips break off	Very tough, harder to chip than cast iron	Soft and easily cut or chipped	Easily cut or chipped	Metal is usually very hard but can be chipped	**	Very easily cut	Easily cut; more brittle than copper	Very easily cut	Chips easily	Chips easily	Chips so easily it can be cut with knife
SPEED OF MELTING (From Cold State)	Moderate	Moderate	Moderate	Fast	Fast	Fast	**	Slow	Moderate to fast	Faster than steel	Slower than steel	Slower than steel	Very fast
COLOR CHANGE WHILE HEATING	Becomes dull red before melting	Becomes dull red before melting	Becomes red before melting	Becomes bright red before melting	Becomes bright red before melting	Becomes bright red before melting	**	May turn black, then red; copper color may become more intense	Becomes noticeably red before melting	No apparent change in color	Becomes red before melting	Becomes red before melting	No apparent change
APPEARANCE OF SLAG	A medium film develops	A thick film develops	A medium film develops	Oily or greasy appearance with white lines	Similar to molten metal	Similar to molten metal	**	So little slag that it is hardly noticeable	Various quantities of white fumes, though bronze may not have any	Stiff black scum	Gray scum; considerable amounts	Gray scum; less slag than Monel Metal	Dull gray coating
ACTION OF SLAG	Quiet; tough, but can be broken	Quiet; tough, but possible to break	Quiet; tough, but can be broken	Quiet; easily broken up	Quiet	Quiet	**	Quiet	Appears as fumes	Quiet	Quiet; hard to break	Quiet; hard to break	Quiet
APPEARANCE OF MOLTEN PUDDLE	Fluid and watery; reddish white	Fluid and watery; reddish white	Fluid and watery; straw color	Liquid; straw color	Liquid; straw color	Lighter than low-carbon steel; has a cellular appearance	**	Has mirrorlike surface directly under flame	Liquid	Same color as unheated metal; very fluid under slag	Fluid under slag	Fluid under slag film	White and fluid under slag
ACTION OF MOLTEN PUDDLE UNDER BLOWPIPE FLAME	Quiet; no sparks; depression under flame disappears when flame is removed	Quiet; no sparks; depression under flame disappears when flame is removed	Boils and leaves blowholes; surface metal sparks; interior does not	Does not get viscous; generally quiet; may be slight tendency to spark	Molten metal sparks	Sparks more freely than low-carbon steel	**	Tendency to bubble; puddle solidifies slowly and may sink slightly	Like drops of water; with oxidizing flame will bubble	Quiet	Quiet	Quiet	Quiet; may boil if too hot

* Malleable iron should always be bronze-welded.

** Alloy steels vary so much in composition and consequently in results of tests that experience is the best solution to identification problems. Data given is for stainless steel.

† Due to white or light color and extremely light weight aluminum is usually easily distinguishable from all other metals; aluminum alloys are usually harder and slightly darker in color than pure aluminum.

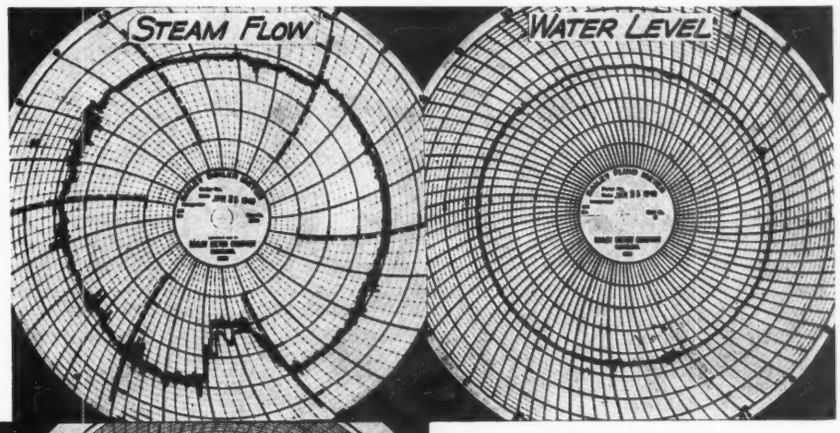
†† Weight, softness, and great ductility are distinguishing characteristics of lead.

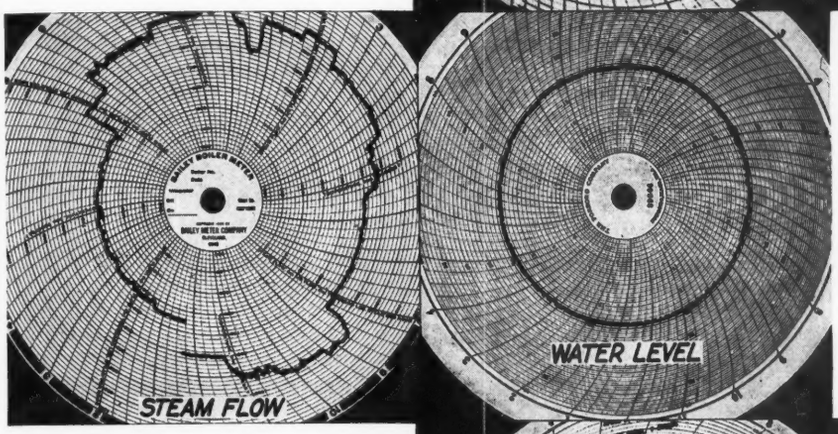
Courtesy Linde Air Products Co.

Data Sheet No. 100

1300 POUNDS W.S.P.—

Fired with pulverized coal or oil, this 1300-pound B. & W. boiler in a prominent Eastern utility plant normally evaporates 275,000 pounds per hour with a maximum of 300,000 pounds. Excess water pressure at pump discharge is 250-300 pounds. The boiler water level is held within plus or minus one inch of the desired normal by the COPES Flowmatic Regulator.



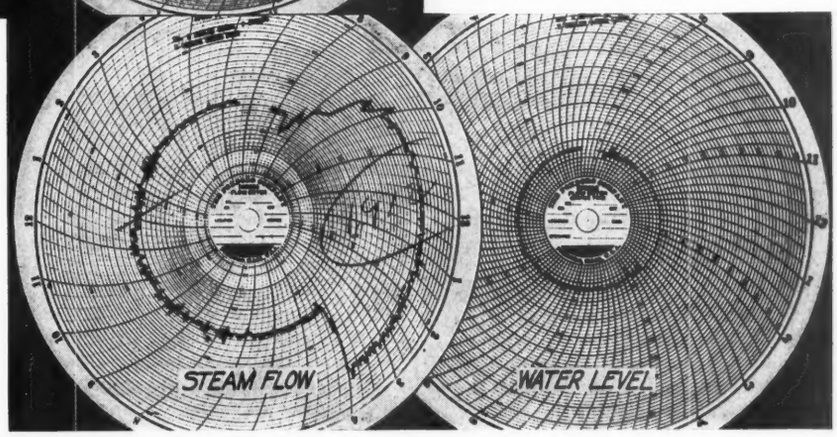


—875 POUNDS W.S.P.

Powdered coal firing. 875-pound, 860-degree, Foster Wheeler 3-drum boiler. The maximum evaporation with this utility boiler is 400,000 pounds per hour; normal, 330,000 pounds per hour. The motor-driven centrifugal pump has no automatic pressure control. Extreme water level range permitted by COPES Flowmatic is 1.6 inches.

600 POUNDS W.S.P.—

Firing with acid sludge or gas, normal evaporation is as high as 350,000 pounds per hour on this 600-pound pressure Riley Steam Generator. Boiler water level is carried one inch higher at peak load of 360,000 pounds per hour than at normal minimum of 242,000 pounds per hour. The level control by COPES Flowmatic is unusually close on all loads.



Why worry about water level?

The COPES Flowmatic is daily demonstrating close level control at pressures from 80 to 1325 pounds—for capacities up to 550,000 pounds per hour. Write for Bulletin 429, showing typical charts and explaining operation.

NORTHERN EQUIPMENT CO., 1101 GROVE DRIVE, ERIE, PA.

Feed Water Regulators, Pump Governors, Differential Valves
Liquid Level Controls, Reducing Valves and Desuperheaters

★ GET CLOSER LEVEL CONTROL WITH THE COPES FLOWMATIC ★ REGULATOR

POWER LINES

Wind Power Plant for Green Mountains

An experimental wind power-generating plant rated 1000 kw is under construction on Grandpa's Knob, near Hubbardton, Vt., under the sponsorship of the S Morgan Smith Co, York, Pa., and with the cooperation of the General Electric Co, Wellman Engineering Co, Cleveland, Edward G Budd Mfg Co, Philadelphia, American Bridge Co, Pittsburgh, and the Green Mountain Power Corp, Rutland, Vt. Energy developed is to be delivered into the Green Mountain system, and it is planned to complete the installation during the first half of 1941. The work is the outcome of an investigation and tests extending over the past half-decade, and a number of renowned specialists have been enlisted in the project.

The wind turbine has been designed by Palmer Cosslett Putnam of Boston, aeroelectric consultant, for the S Morgan Smith Co, and chief engineer of the undertaking is Dr J Wilbur, director of the structural analysis laboratory of the Massachusetts Institute of Technology. Wind-tunnel studies back of the development have been conducted at the California Institute of Technology by Prof Elliott Reid of Stanford University and Dr Theodore Troller, director of the Guggenheim Airship Institute, Akron, Ohio, under the supervision of Dr Theodore von Karman, director of the Guggenheim Aeronautical Laboratories at the California institution. John F. Jaines, aeronautical engineer, Dayton, Ohio, is consultant in the solution of aerodynamic and mechanical problems. The design of blade structures has been carried out by Prof Joseph S Newell of the Massachusetts Institute.

New ASME Officers

William A Hanley, director of Eli Lilly & Co, Indianapolis, Ind., and head of its engineering division, was elected by a letter ballot of the 15,000 members of The American Society of Mechanical Engineers to be president during 1941.

Vice-presidents elected at the same time to serve 2-year terms on the Council of the ASME were Samuel B Earle, research engineer and dean of engineering at Clemson Agricultural and Mechanical College, Clemson, S.C.; Frank H Prouty, a partner in the Prouty Brothers Engineering Co and the Industrial Appraisal Company, both in Denver, Colo.; and Edwin B Ricketts, mechanical engineer with the Consolidated Edison Co of New York, Inc, New York, N. Y.

Managers of the Society elected to serve on Council for 3-year terms included Huber O Croft, professor of mechanical engineering and head of the department at the University of Iowa, Iowa City, Iowa; Paul B Eaton, consulting engineer, and professor and head of the mechanical-engineering department at Lafayette College, Easton, Pa.; and George E Hulse, chief engineer, The Safety Car Heating and Lighting Co, New Haven, Conn.

The new officers will be installed during the 61st Annual Meeting of the ASME in New York, N. Y., at the Hotel Astor, Dec. 2-6, 1940.

New England Prepares for Defense Loads

The two major power systems of New England have already taken steps to keep well ahead of any increasing demands occasioned by the national defense program, according to an announcement from Frank D Comerford, president of Boston Edison Co and chairman of the board of New England Power Association.

Mr Comerford revealed that Boston Edison Co, which increased its capacity by 65,000 kw in 1939 through the installation of new units at its two major plants, has placed orders for two additional 1200-lb, General Electric generating units, which will add 58,000 more kw, and which are scheduled for delivery by the spring of 1942. Two Combustion Engineering boilers are also to be added.

At the same time construction has been speeded up on the installation of 40,000 additional kw by the Narragansett Electric Co at Providence, a part of the New England Power system, and this unit is expected to be in operation early in 1941.

With the completion of these projects, these two large systems, which are interconnected at four major points, and which if necessary can be operated as a unit, will have 163,000 more kw of capacity than on January 1, 1939.

Work is already under way at the Boston Edison Co's plant at L Street, South Boston, for installation of an 18,000-kw unit, to be delivered early in 1942. It will be placed in the same building which houses the 25,000-kw "topping unit," placed in operation in 1939. The other unit ordered by Boston Edison, 40,000 kw, has not yet been definitely placed.

Erwin Cotton Mills Expand

Four orders have been issued for equipment for the boiler-plant extension to the Erwin Cotton Mills at West Durham, N. C., through the consulting and designing en-

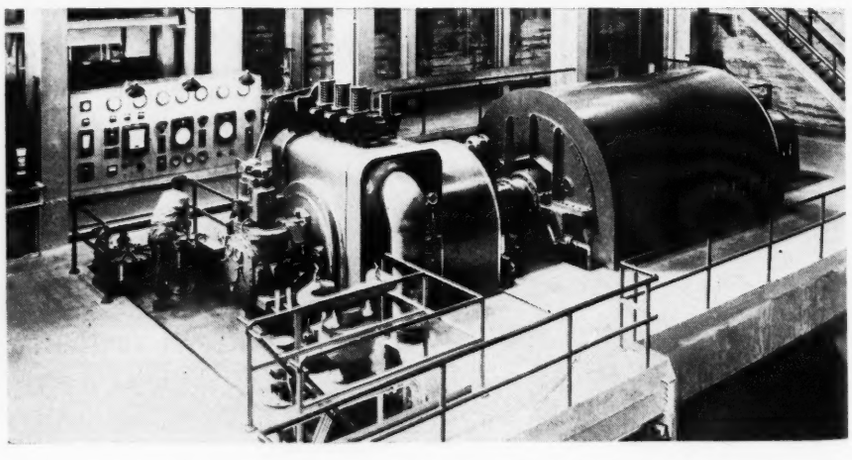
(Continued on page 164)

Westport Generator Eliminates Double-Frequency Vibration

Double-frequency vibration, heretofore a special problem in 2-pole turbine-generators, has been practically eliminated by General Electric in a spring-mounted, 3600-rpm generator recently installed in the Westport station of the Consolidated Gas, Electric Light and Power Co of Baltimore. The new generator, installed in July, is the first of its type to be put into operation. The spring-mounted design of the 25,000-kw turbine-generator isolates vibration so well that it is impossible for a man standing alongside the generator to tell, either by sound or by touch, when excitation is applied or removed.

This reduction is accomplished by flexible-mounting the stator structure. Isolating the vibration at its source and confining it to the laminated core, this resilient core mounting does away with the annoying 120-cycle "transformer hum" which has always been characteristic of large high-speed generators under excitation. Also transmission of the double-frequency 7200-per-minute disturbances to the foundation and nearby structure is prevented.

While simple in construction, the resilient core mounting involves a great many considerations in design. Heretofore, the laminated core has been stacked on long dovetail "key-bars," or "ribs," which have been attached directly to the frame. In the new construction, the same "key-bars" are employed but are attached to twin sets of spring-bars which in turn are joined to the frame in such a way as to provide flexibility between the key-bars and the frame. Vibrations are thus absorbed by a flexibly mounted core, resilient enough to prevent them from being transmitted to the frame.



YOURS FOR THE ASKING!

60 pages of up-to-the-minute data on condenser and heat exchanger tubes and plates

In this new book you will find many practical suggestions to answer such problems as... What alloy has given the most economical results in this particular type of service? What are its properties? What is its performance record...? And what are the advantages of duplex tubes...etc., etc.

In addition, there is a complete appendix giving temperature conversion tables, steam pressure tables, and the Mollier Diagram.

This is a book you will want at your elbow. All you need do to get your complimentary copy is to fill out, tear out and mail to us the coupon below.

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Please send me FREE copy of Condenser Tube Booklet B-2, fifth edition.

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*State*_____

Scarred Knees . . .

HERE'S THE STORY of the man who didn't get the job. A chief asked a friend to recommend an assistant—but the man the friend sent was never hired. The chief explained his negative decision thus: "Your man knew his business, and I almost hired him. BUT—he'd lost a finger at the canning factory, he'd been scalded at the packing plant, and fallen off a ladder at the lumber yard. It just wasn't safe to take a chance on him in a power plant! When I was a kid, my father told me never to buy a horse with scarred knees—he'd be likely to fall again."

There are, I honestly believe, some men who are "accident prone." Accidents either happen to them or have a peculiar habit of happening around them. I remember a laborer named Reinhold Bohn in one plant where I worked. He drew trouble like honey draws flies. For example: We narrowly averted a crane wreck. The only man hurt was Bohn—who was in the next building He was up a ladder helping the pipefitter take down some old steampipe. When he heard the crane whistle he expected trouble—and dropped his end of the pipe, knocking himself off the ladder. Bohn fell 10 feet to a concrete floor, bounced twice, and cut his ear lobe against a door. Outside that, he wasn't hurt.

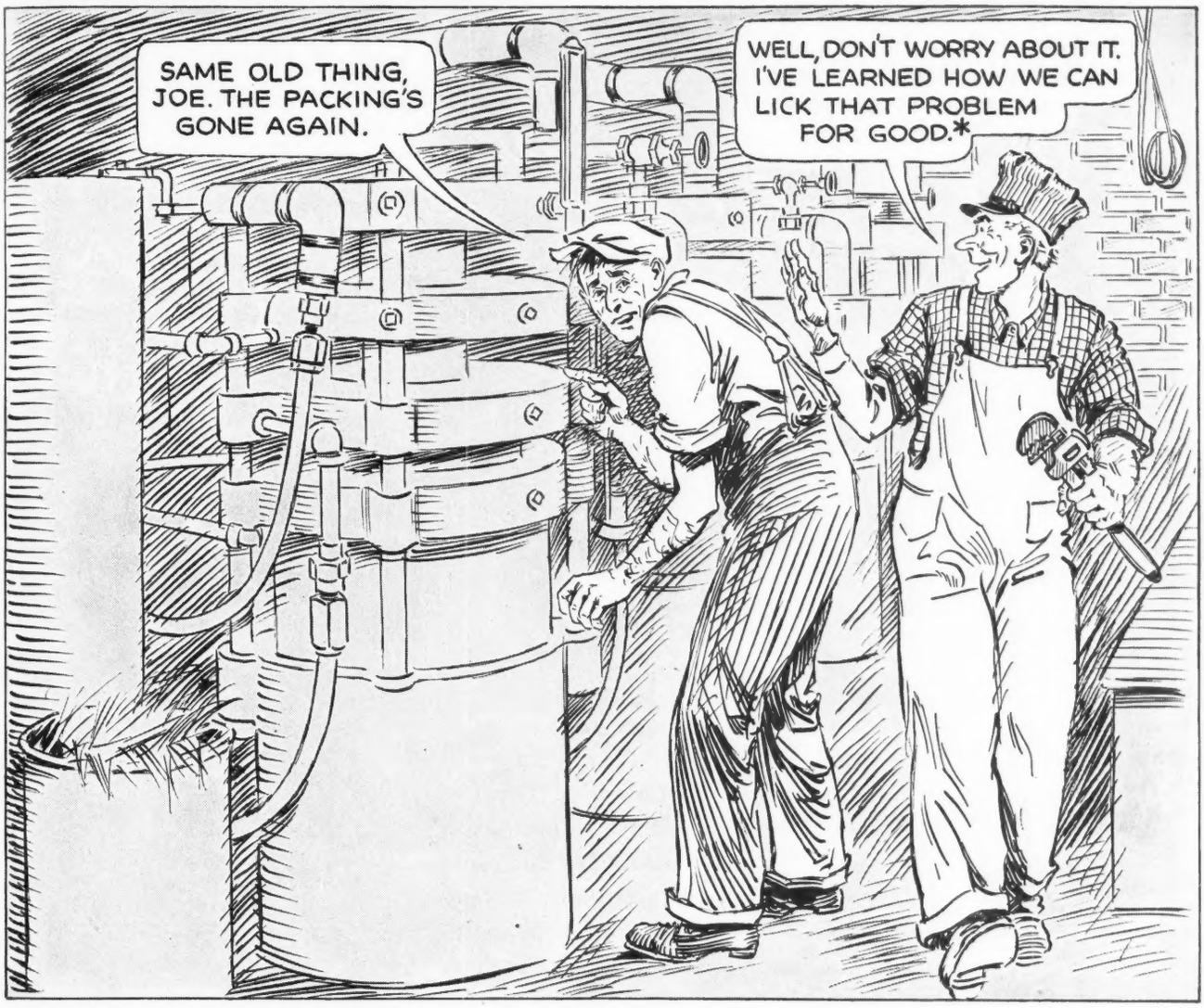
But within two weeks he'd dropped his end of a timber to crush his partner's foot, and had been right at the scene in another accident. Like dynamite, he wasn't safe to have around.

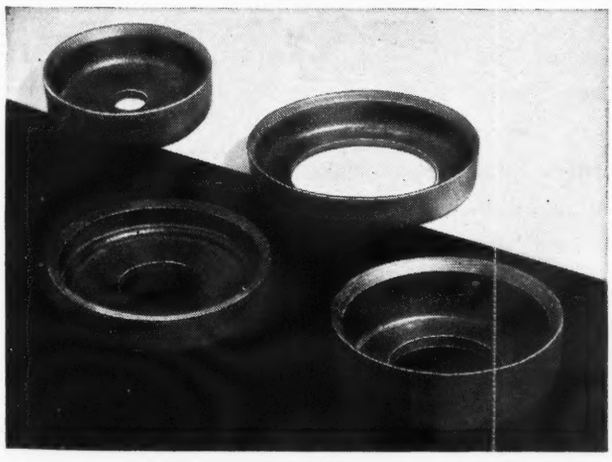
People like Bohn make insurance expensive. One scarred-knee workman can make things unsafe for ten normal men, so if you have a Bohn on your staff, take special pains with him. Use him where he can't hurt himself or others—and meanwhile give him training in the meaning and practice of safety.

George Edwards
Engineer

KEEPING 'EM ROLLING

By WESTCOTT





J-M MOULDED PACKING CUPS for steam brake cylinders, hydraulic presses, air hoists and slow-moving pistons with a relatively short travel. The composition is varied to meet service conditions.

JOHNS-MANVILLE JM PRODUCTS

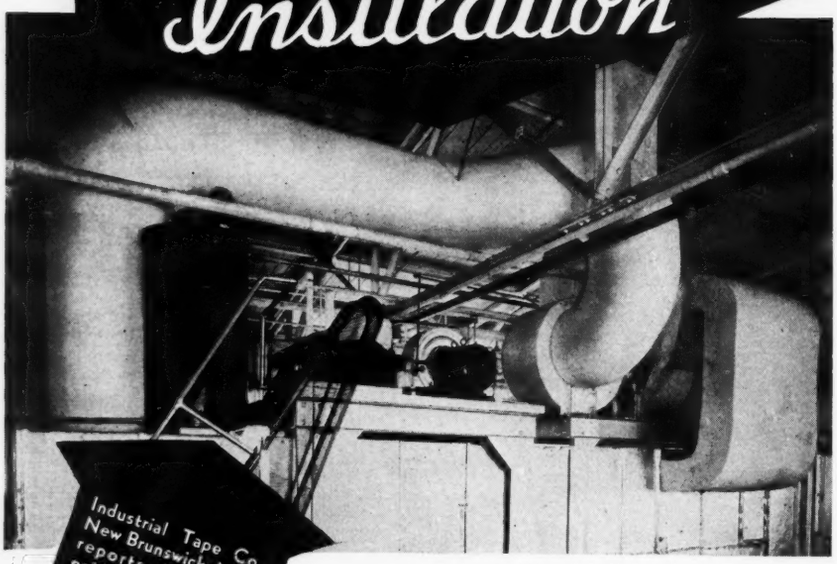
*WHAT JOE LEARNED . . . *J-M Packing Cups last longer . . . provide a tighter seal*

YOU can't figure packing costs on *materials* alone. For every replacement means a shutdown . . . and every shutdown means extra labor, idle equipment. To cut these expenses, engineers are standardizing on J-M Moulded Packing Cups for slow-moving pistons and rams. These durable packings come in a wide variety of types and shapes . . . each for a specific service. All are moulded to the exact size needed . . . assure free action. Like every packing in the complete J-M line, they provide long, dependable life . . . boost efficiency, lower costs. For details on J-M Packings and Gaskets, write for Catalog PK-3A. Johns-Manville, 22 E. 40th St., New York, N. Y.

JOHNS-MANVILLE PACKINGS & GASKETS

THERE'S A DISTRIBUTOR NEAR YOU

Eliminate Lag on Heat Control by using Baldwin-Hill Insulation



Industrial Tape Co., New Brunswick, N. J., reports, "Insulation paid for itself within a few weeks of installation." Ducts on this processing oven were insulated with 1" B-H Black Rockwool Blanket, finished with 1/2" B-H No. 1 Insulating Cement.

LAG is an expensive item in production! . . . Time taken to bring temperature to operating degree . . . Fluctuation of temperatures . . . Difficulty in maintaining close control of the heat treating area of the equipment.

Baldwin-Hill Insulation of the correct type and thickness, properly applied, is a primary factor in eliminating lag. It reduces heat losses through outside surfaces of the equipment and facilitates a constant control of operating temperatures.

For any specific application or insulation problem, call in a Baldwin-Hill insulation engineer.

Send for Catalog

for complete data on entire line showing applications, insulating efficiencies, heat loss charts, etc.

B-H Black Rockwool Blanket

B-H No. 1 Insulating Cement
B-H Mono-Block

B-H No. 100 Pipe Covering
B-H Weatherseal

and other B-H insulating materials effective up to 2000° F.

BALDWIN-HILL CO.

575 KLAGG AVE. . . . . TRENTON, N. J.

New York – Boston – Chicago – Kalamazoo, Mich.

Small Boiler Plants

(*Continued from page 79*)

this stoker and an underfeed burning high-grade coals. At light loads, use of only half the grate area improves efficiency under these conditions, usually difficult with all small stokers and particularly with spreaders.

A number of manufacturers now produce small boiler units with integral water-cooled furnaces. This construction permits use of steel-cased, insulated settings, eliminating most of the usual brickwork. The net result is a unit of low first cost which is economical of space, easy to operate, and yields high efficiency with low maintenance cost. The 25,000-lb-per-hr unit at Magee Hospital, Pittsburgh (Fig. 4), represents an interesting application of such a unit and affords a good comparison with earlier practice.

Two or three return-tubular boilers, originally fired with V-type overfeed stokers and later converted to underfeeds, formerly carried the hospital loads. A Riley RO boiler, with integral water-cooled furnace and economizer, replaced one of these units; the Westinghouse single-retort stoker from the old unit was rebuilt and now fires the new. The modern boiler carries the entire hospital load and, in addition to decreased coal consumption, has made possible the use of a lower grade coal.

Particular interest attaches to the decision to rely on a single boiler for normal service in a hospital, where electric generating units, pumps, sterilizers, etc, operate continuously. The installation of a single unit large enough to carry the entire load permitted modernizing the plant at minimum cost. The new unit went into the existing boiler house without any alterations and the older units are used only when the new one must be shut down.

Reader's Problems

(*Continued from page 115*)

stance on starting up. If such is the case, an intermediate separator could be installed midway between the present installation and the boiler.

Galt, Ontario HARRY PARKINSON

Trap Lowest Point

THERE IS NO CONNECTION between cracking the engine-cylinder head in starting and any water in the steam while running.

Predetermined Seating

an outstanding feature of the

Chapman Motor Unit
Yoke Mounted on Valve Bonnet
Direct or Remote Push Button Control

Chapman MOTOR UNIT

Assurance of proper seating is a matter of primary importance in selecting motor units for the electrical operation of valves. In the Chapman Motor Unit this is most effectively provided for in the *micrometer adjusted* quick break limit switch, an exclusive Chapman feature.

This Chapman Limit Switch controls seating to any *predetermined* tightness, and is the real heart of the motor unit. The setting is absolutely mechanical, without springs or spring devices which are liable to cause jamming. This predetermined seating gives assurance that the valve will always seat properly, irrespective of pressure or temperature. It prevents wearing of the seat from galling and reduces maintenance costs. It also assures continuity of operation and reduces probability of distortion of the valve due to shock of closing.

This and other notable features make Chapman Motor Units outstanding in all fields of application. Widespread use in the power field is good evidence of superior qualifications for exacting service.

THE CHAPMAN VALVE
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GET *Better Control* FOR *Less Money*

THESE pressure regulators give you accurate control of air, water and steam pressures—saving you money by reducing waste, by cutting maintenance costs and by minimizing time out of service. Your maintenance crew, your production superintendent and your treasurer will all appreciate the extra value built into Masoneilan Regulators. Your mill supply distributor will appreciate the opportunity to give you complete details.

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In starting an engine, if the cylinders are not properly drained and sufficiently warmed, the cylinder head can be cracked even though the steam is perfectly dry. DLW does not state the reason that makes him think there is water in the steam and he is wrong if he thinks that because the cylinder head was cracked in starting there must be water in the steam.

He mentions a separator at the engine but says nothing of any traps. There should be at least one trap ahead of the engine. The separator takes care of any water while the engine runs, but with the engine out of service, if there is no trap at the lowest point of the line, the entire 250-ft length can fill with condensation and the separator will not be adequate to take care of it in starting. My advice to DLW is to see that there is a trap at the lowest point of the line and to make sure that it is working.

Oak Park, Ill. N T PEF

Survey Line for Low Points

THE QUESTION STATES that DLW has a single-valve, high-speed engine with a "standard-size" separator in the steam line. It is safe to assume that this is a small cast-iron separator with volume probably equal to the cylinder volume of the engine. A large receiver-type separator with volume 4 to 6 times the engine cylinder volume should be used. This separator should be drained into a trap of good capacity, capable of withstanding the pulsating steam flow, and serving this one separator only. The connection between the separator and the trap should be as direct as possible. This type of separator and trap could be relied on to take normal condensation out of the steam.

The steam pipeline should then be carefully surveyed to make sure that there are no pockets or low points in which condensate could accumulate, later to be carried over to the engine as "slugs". In 250 feet of line it may be impossible for it all to drain naturally in one direction, and if this is the case, the natural low spot should be selected and a separator and trap installed at that point to remove accumulated condensate. This separator need not be so large, but piping to it and from it should be removed before the steam flow can carry it on. Before starting up, both separators should be drained and the steam line warmed up.

St. Louis, Mo. A L FREULER

Engineers' Books

(*Continued from page 124*)

of cycle, and suggestions and data for station design and layout.

Intended primarily as a text for college classes in mechanical engineering, this book presents a concise picture of steam-power practice, and as such will prove useful to practicing engineers. The emphasis is on central stations, although some phases of industrial-plant design are included.

(Left) Actual photograph of a Gulf engineer consulting with the Chief Engineer of this large plant on a Periodic Consultation Service call.

"The economic advantage of GULF PERIODIC CONSULTATION SERVICE is clearly evident in Our Lower Operating Costs"

"OUR experience with Gulf Parvis Oil covers a period of fifteen years, and we're satisfied that its higher quality has been responsible for our enviable operating records," says this Chief Engineer. "It is our belief that Gulf Parvis Oil is the ideal lubricating oil for our Diesels."

More than fifty of America's leading Diesel engine builders have approved Gulf Parvis Oil for the engines they build! This high quality oil retains its lubricating value longer under severe operating conditions, provides maximum protection at a lower consumption rate, and contributes to full power and operating efficiency.

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Specialty

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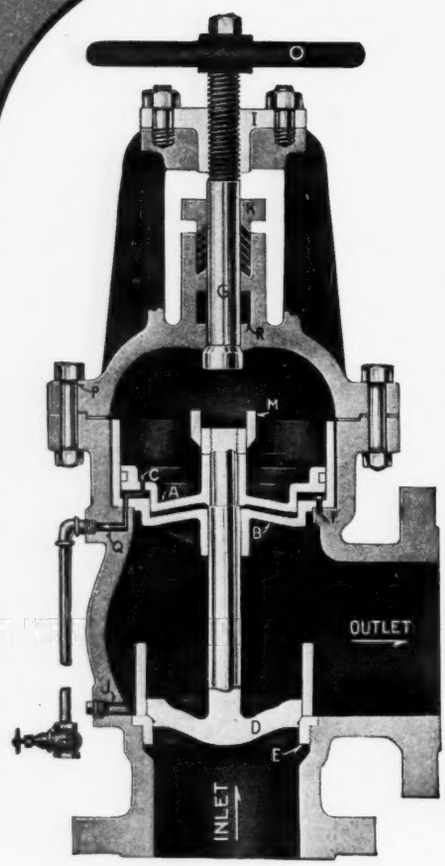

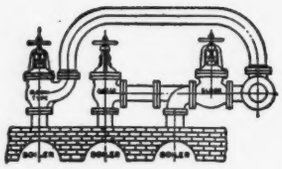

NON-RETURN

• A tube bursting in one boiler means that the contents of every boiler in that battery are coming through that rupture *unless* there's a good non-return valve to stop it. To guard against such destruction, install an efficient, non-return valve that *will not* and *cannot* stick—such as the G-A non-return valve shown here. As far as we know, none of the many thousands in use has ever failed.

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Diesel Engines

DIESEL-ENGINE CATALOG (Volume V, 1940). *Rex W Wadman, Editor. Published by Diesel Engines, Inc, 2 W 45 St, New York, N. Y. 270 text pages, 10x13½ in., numerous illustrations and tables, loose-leaf binding. Price $5.00.*

The basic idea of this work is to gather together, in one place, descriptions and basic data on the many types and sizes of diesel engines available in the United States. No attempt is made to present a critical analysis or make comparisons, but the engineer interested in diesels will find useful information as to construction, sizes, power and speed ranges, and applications for which specific engines are intended. An added section covers fuel-injection pumps and nozzles.

Cross-section drawings and photographs of parts serve to make construction features clear. For many engines specification tables are given as well as performance curves. A directory of diesel-engine and accessory manufacturers is also included.

Pumps

PUMPS (First Edition, 1940). *By Frank A Kristal, New York District Manager, Weinman Pump Mfg Co, and F A Annett, Associate Editor,* POWER. *Published by McGraw-Hill Book Co, Inc, 330 W 42nd St, New York, N. Y. 339 pages, 6x9 in., 385 illustrations, 16 tables, cloth binding. Price, $3.50.*

To the unsuspecting reader, it must be pointed out that this book was co-authored by a POWER editor, Fred A Annett. However, we can, without partisanship or left-handed loyalty, predict for "Pumps" a future as a "best-seller" among technical books, because it adheres to Fred's by-word, "Be Practical." Most previous volumes on pumps have been mathematical treatments of design. Here for the first time is a comprehensive picture of the pump types available, how they operate, how they are used and how to apply them.

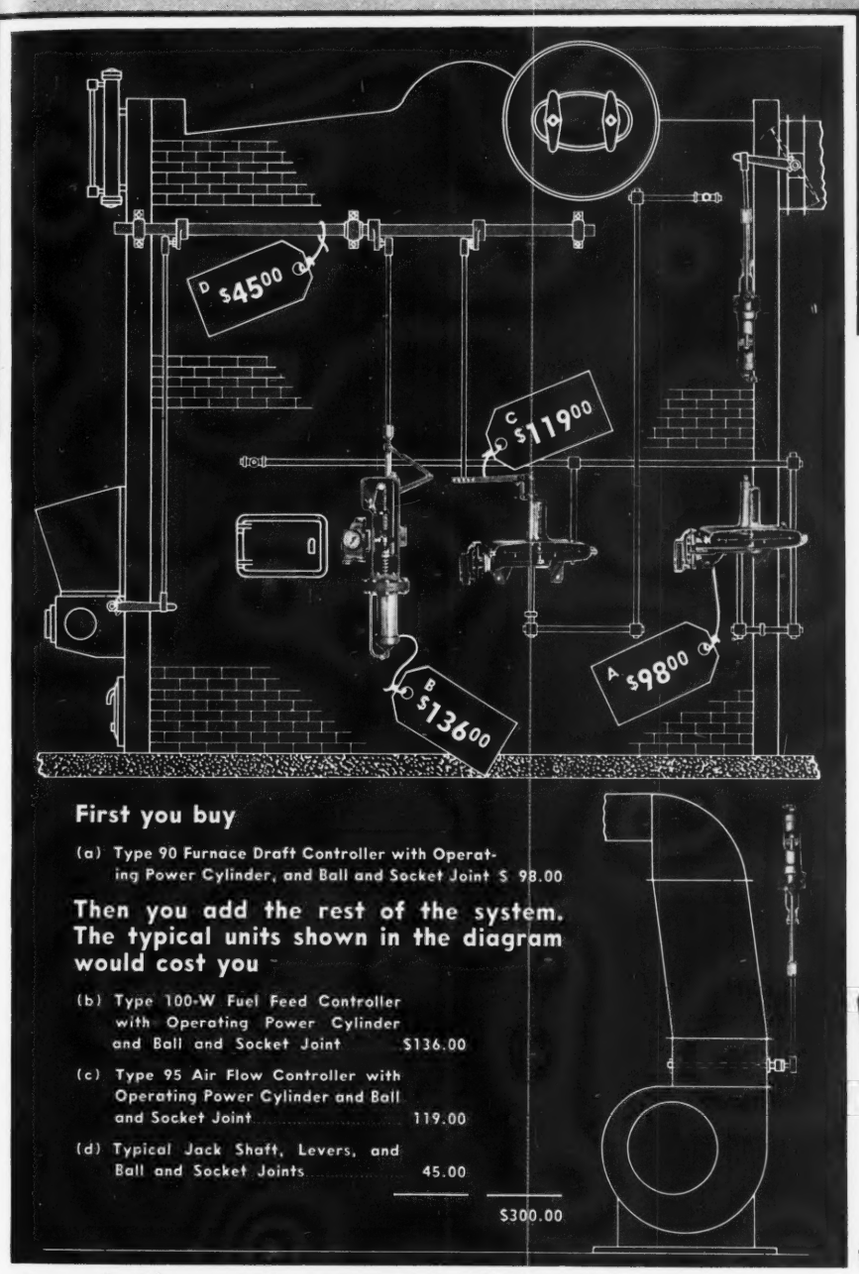
The first of 18 chapters, 52 pages, deals with the various types of reciprocating pumps for both low and high pressure. The remainder of the book deals mainly with rotating pumps and includes volute and diffuser-type centrifugal, turbine, propeller, rotary, deep well, variable-displacement and proportioning designs.

Boiler-feed pumps; sewage and sump pumps; method of priming; how to figure head on a pump; economical pipe sizes for pumps; pump operation; drives for pumps: pump selection, installation and care: troubles and remedies, and new pumps for old are subjects of other chapters. In many of these, there is pointed out application of pumps to specific industries, such as chemical, oil refining, oil fields, pulp and paper, metal refining, handling of abrasive materials, etc.—BES.

Coal

COAL—ITS PROPERTIES, ANALYSIS, CLASSIFICATION, GEOLOGY, EXTRACTION, USES, AND DISTRIBUTION (2nd edition, 1940). *By Elwood S Moore, Professor of Geol-*

FOR *Better* BOILER ROOM *Profits*



First you buy

(a) Type 90 Furnace Draft Controller with Operating Power Cylinder, and Ball and Socket Joint $ 98.00

Then you add the rest of the system. The typical units shown in the diagram would cost you

(b) Type 100-W Fuel Feed Controller with Operating Power Cylinder and Ball and Socket Joint $136.00

(c) Type 95 Air Flow Controller with Operating Power Cylinder and Ball and Socket Joint 119.00

(d) Typical Jack Shaft, Levers, and Ball and Socket Joints 45.00

$300.00

Read these Important Facts

After you have made the $98.00 investment and found out the many ways you benefit through CASH STANDARD quality and performance, you can get the units tagged B, C and D (see diagram and explanation above) for as little as $300.00.

You can get CASH STANDARD Control Systems on panel boards, but experience has proved that the control units work equally as well mounted individually elsewhere. There is no difference in the quality or design of these units and those we furnish for the most elaborate jobs and the largest kind of boilers. To make this plan workable, the simple requirement is that the control units be installed conveniently near the apparatus they operate without panel board.

BEGIN WITH THE SMALL INVESTMENT OF $98.00

(SEE TAG "A" ON BOILER DIAGRAM)

TAG "A" PRICES THE CASH STANDARD FURNACE DRAFT CONTROLLER

This unit works independently as you will read in its description below — it is, therefore, the logical unit to begin with, with a view to getting a complete

AUTOMATIC COMBUSTION CONTROL SYSTEM

Check THE FOLLOWING AGAINST THE BOILER DIAGRAM

TAG A—FURNACE DRAFT CONTROLLER
This CASH STANDARD Furnace Draft Controller (which comes complete with Operating Power Cylinder) works from overfire draft, regulating the boiler uptake damper, to maintain a constant draft in the combustion chamber. Place it near the uptake damper. It works independently of either of the two Controllers B and C shown in illustration. It does its part toward money-saving by eliminating wasteful air infiltration.

TAG B—FUEL FEED CONTROLLER
This CASH STANDARD Master Controller automatically regulates fuel feed. Locate it conveniently. Working from boiler pressure, it will adjust the rate of combustion by regulating the rate at which fuel (any kind of fuel) is supplied to the boiler furnace. And it will adjust the Air Flow Controller so the correct amount of air is supplied for proper combustion — hence, money saving.

TAG C—AIR FLOW CONTROLLER
This CASH STANDARD Air Flow Controller meters the air needed for combustion. Install it near its damper. It is not affected by changes in fuel bed resistance or any other variables, because it meters air supply according to the differential pressure through the gas passages of the boiler, doing its part to insure perfect combustion.

Don't hesitate to write for more details — there is no obligation — many companies began their Automatic Combustion control with the* CASH STANDARD *Furnace Draft Controller and now have the complete system — let us give you all of the interesting, important facts.

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CASH STANDARD
CONTROLS . . VALVES

Fairbanks Iron Valves on House Service Pumps, Hotel New Yorker, New York

Valves, like other equipment in hotels, must give service 24-hours a day, 7 days a week.

To assure dependable control of the water service for the 2500 rooms in the hotel New Yorker, New York, Fairbanks Valves were installed throughout the entire plumbing system.

At a recent interview, Mr. W. D. Lewis, Chief Engineer, stated that their Fairbanks Valves have cost practically nothing for upkeep during the many years they have been in service and that no repair parts have been required.

Fairbanks Valves are made in globe, gate, angle, check and cross patterns for a large range of pressures . . . in metals best suited for the service desired.

Our engineers are, at all times, ready to assist in solving difficult valve problems without cost to you.

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Fairbanks F
Standard and Renewable **Valves**

ogy, University of Toronto. Published by John Wiley & Sons, Inc, 440 4th Ave, New York, N. Y. 473 pages, 6x9 in., 151 illustrations, 20 plates, numerous tables. Price $6.00.

To cover advances in coal technology since 1922 when the first edition of "Coal" appeared, Prof Moore has added material on petrology and chemistry of coal, on classification, and on improvements in methods of extraction, preparation for market, and utilization. Chapters dealing with the world's coal resources were originally based on "Coal Resources of the World", and since no report of the same scope has since been issued, only minor revisions have been made.

For the benefit of those not familiar with the first edition, it should be said that Prof Moore covers, in a simple and practical way, the physical and chemical properties of coal, the origins of coal, methods of classification, structural features, prospecting, valuation of properties, methods of extraction, preparation of coal for the market, and coal resources of the world, analysed by continent and country.

Although written for coal technicians, this book will yield much valuable background information for anyone in the power field whose duties include coal selection.

Electrical Troubleshooting

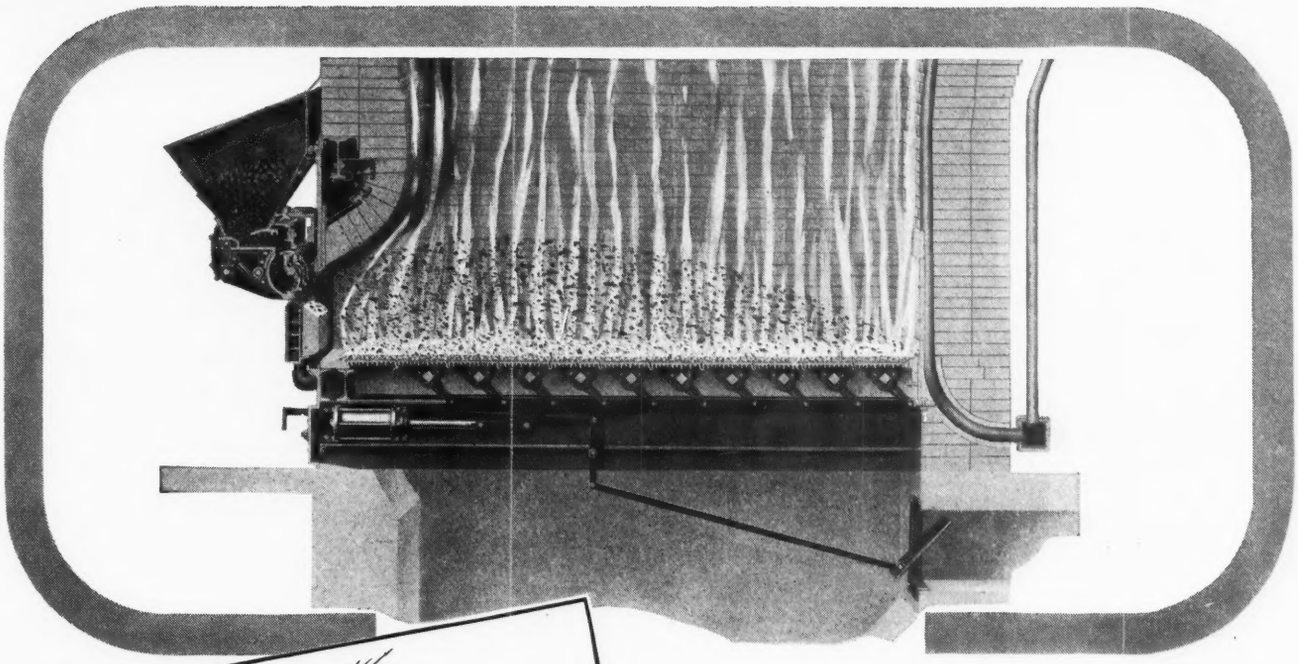
TROUBLES OF ELECTRICAL EQUIPMENT (2nd Edition, 1940). *By H E Stafford. Published by McGraw-Hill Publishing Co, 330 W 42nd St, New York, N. Y. 373 pages, 6x9 in., 330 illustrations; 25 tables, cloth binding. Price $3.00.*

To prevent troubles by adequate inspection and to locate and correct faults when they develop is the job of the maintenance engineer. It is to these problems in electrical equipment that this book is directed. It covers practically every type of electrical equipment, both ac and dc, found in industrial plants. In dealing with the various troubles, first the symptoms of the faults are given and then by diagrams and explanations it is shown why faults produce the symptoms common to them. The end of each chapter dealing with a specific class of equipment sums up for quick reference the symptoms, troubles, causes and remedies.

In addition to troubles and remedies, the book also treats of such subjects as industrial control, selecting motors for industrial applications, economic use of power, power factor, industrial-plant lubrication, etc. The chapter on industrial-plant lubrication in this new edition has been rewritten to bring it up to date and a 44-page chapter has been added on location of faults in cables. This book should be useful to any electrical worker no matter how limited his technical training.

Brief Reviews

INSTANT POWER CALCULATOR. *By E W Roberts, 411 Ludlow Ave, Cincinnati, Ohio. Card type calculator, price $.25.*—By setting stroke on one part of calculator with bore on other part, brake horsepower can be found in line with explosions per minute. Other information and typical examples given on reverse side.



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a stoker that burns efficiently bituminous or subbituminous coal, coke breeze, petroleum coke and other low-grade fuels from 2½" lump to dust—in any grading, wet or dry.

WHITING GIVES YOU AN IMPARTIAL CONSULTING SERVICE

Because Whiting manufactures all three types of industrial stokers—underfeed—horizontal compression (overfeed)—spreader—its engineers are in a position to give you unbiased, unprejudiced advice in the selection of a stoker best suited to fit *your* individual problem. The coupon below will bring you that service.

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1. Low application cost to any type of furnace or boiler from 80 to 2000 h.p.
2. Design and construction insure minimum boiler outage. All parts readily accessible.
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8. Minimum of power necessary to drive—only a 1½ h.p. motor required for a 500 h.p. boiler.
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Chicago Building SAVES $781 PER YEAR on fuel with "RANAREX"* CO_2 Indicator and Recorder!

As a direct result of installing a Ranarex CO_2 Indicator and Recorder, The Real Estate Corporation, Managers of the Times Building, Chicago, report *annual* savings of $781 on fuel — more than twice the purchase price of their Ranarex equipment!

H. Edsall Olson, President, writes: "We have in this building two hand-fired 200 horse-power marine-type boilers. Two years' operation under Ranarex has disclosed a saving of 146 tons of coal per year. Translated into dollars that means a saving of $781.10 per year."

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*TRADEMARK REG. U. S. PAT. OFF.

MANUAL OF ORDINANCES AND REQUIREMENTS. *Official Publication of Smoke Prevention Assn of America, Inc, 139 North Clark St, Chicago, Ill. 160 pages, paper bound. Price $.60.*—Manual deals with various phases of smoke-abatement work, includes information helpful to municipalities establishing smoke-prevention laws, and to architects, builders, etc, in the designing of factories, power plants, etc, to whom the smoke-abatement problem is important.

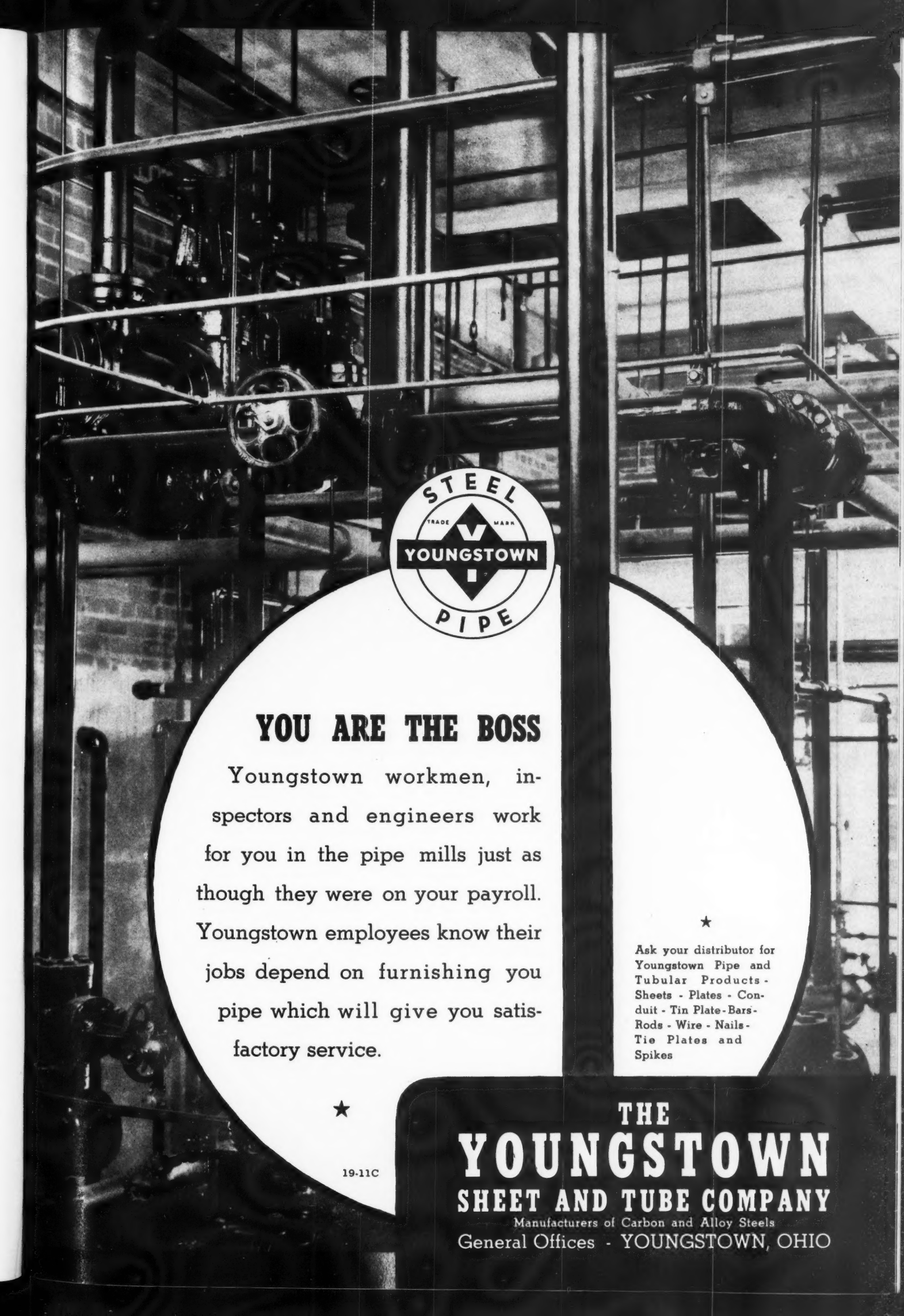
SIMPLE BLUEPRINT READING WITH SPECIAL REFERENCE TO WELDING. *Published by Lincoln Electric Co, Cleveland, Ohio. 138 pages, 6x9 in. 164 illustrations, semi-flexible cover. Price $.50 postpaid in U. S., $.75 elsewhere.*—Beginning with an introduction pointing out the importance of being able to read blueprints, the volume takes up some of the following: simple welded object presented as a study, isometric drawing and discussion, limitations of these and other picture drawings, cutting plane lines, examples of simple and complex blueprints with picture drawings to explain them, omitted parts of drawings, development of basic weld symbols, method of indicating weld position, type of weld, size and shape of weld, sections of over 35 different welds with their corresponding symbols, special symbol instruction drawings and discussion. Illustrations in book include practical examples of drawings of a number of machine parts, pipe connections, general construction, tanks, etc.

WILEY TRIGONOMETRIC TABLES (1940). *Assembled by H A Simmons and C D Gore. Published by John Wiley & Sons, Inc, 440 4th Ave, New York, N. Y. Price 75 cents.*—Contains the following tables: (1) squares and square roots, (2) constants with their logarithms, (3) natural logarithms of numbers, (4) 5-place logarithms of numbers, (5) logarithms of functions, (6) 4-place values of functions and radians.

BOILER INSPECTOR'S MANUAL, *By C C Custer, 1012 Michigan Ave, Logansport, Indiana. 8½x11 in. Paper binding. Price $3.00 or $2.50 a copy for clubs of 10.*—This book is in part a collection of reports and articles the author ran in various technical publications, and in part new material. All of it relates, in one way or another, to the job of the boiler inspector, who will probably find it helpful to have this book in his library. The treatment throughout is strictly practical.

FIRE—ITS CAUSE, PREVENTION AND CONTROL. *By Harold Joe Davis, Safety Engineer, 3927 East Admiral Place, Tulsa, Oklahoma. Paper bound, price $.25.*—Contains principles of combustion, preventing or stopping same, various extinguishing media, inspection and repair of extinguishers, and helpful suggestions for fireproof construction.

REFRACTORIES INVESTIGATION IN MELLON INSTITUTE. *Published by Refractories Fellowship, Mellon Institute, 4400 Fifth Ave, Pittsburgh, Pa. Available on request.*—Presents short history of refractories fellowship, together with numerous photographs showing equipment used in research.



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Youngstown workmen, inspectors and engineers work for you in the pipe mills just as though they were on your payroll. Youngstown employees know their jobs depend on furnishing you pipe which will give you satisfactory service.

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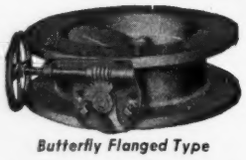

Butterfly Flanged Type

SLIDE TYPE
BUTTERFLY TYPE
KWIKLEEN TYPE
WAFER BUTTERFLY TYPE

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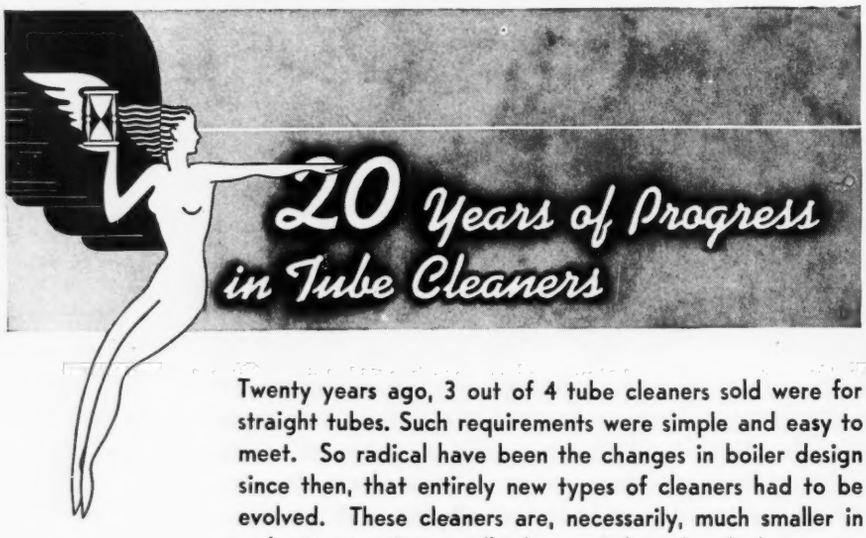
W. S. ROCKWELL CO., 50 Church St., New York



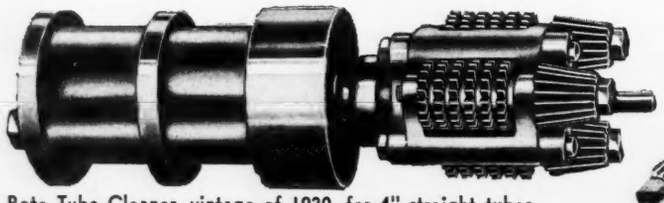
Twenty years ago, 3 out of 4 tube cleaners sold were for straight tubes. Such requirements were simple and easy to meet. So radical have been the changes in boiler design since then, that entirely new types of cleaners had to be evolved. These cleaners are, necessarily, much smaller in order to negotiate small tubes and sharp bends, but, paradoxically, they are bigger in performance.

The builder of your new boiler can furnish you with Roto Tube Cleaners, or you can get them directly from us. In either case, we guarantee that any Roto cleaner we furnish will give satisfactory service.

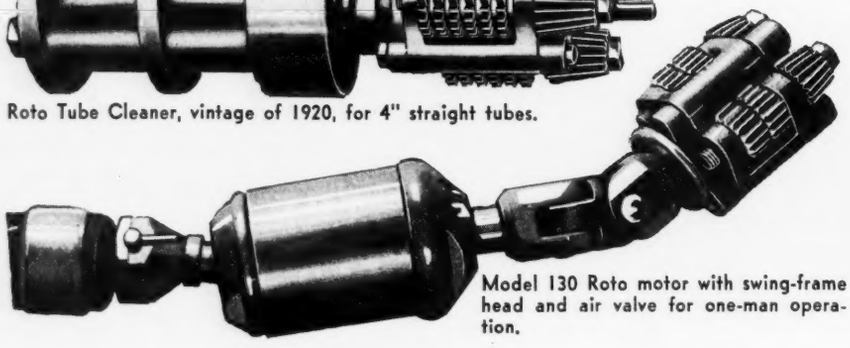
See Our Adv. in Sweet's

The new Roto Tube Cleaners are also available for old type boilers. Replacement parts are always on hand for old type Roto Cleaners, many of which are outliving the boilers.

The ROTO Company
145 Sussex Avenue, Newark, N. J.



Roto Tube Cleaner, vintage of 1920, for 4" straight tubes.



Model 130 Roto motor with swing-frame head and air valve for one-man operation.

New Plant Equipment

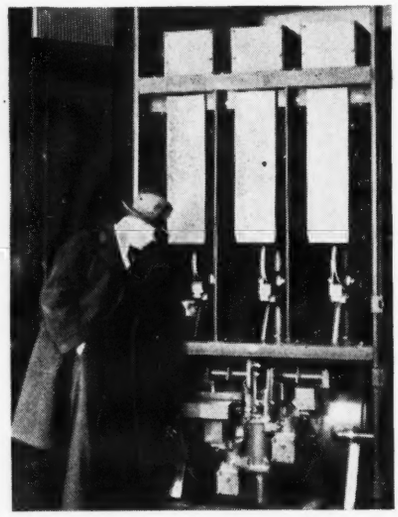
(*Continued from page 130*)

plosive gases or vapors. Special laminated and shatter-proof lens protects light bulb. Spillage of acid from battery is prevented by special design of battery plates which involves principle of capillary action.

Stewart R Browne Mfg Co, Inc, 7376 Grand River, Detroit, Mich.

Circuit Breaker

TYPE CA compressed-air circuit breaker interrupts arcs on "cross blast" principle. Arc is drawn between contacts which open in a line perpendicular to insulating splitter plates. Compressed-air stream is blown at right angles to the arc and elongates it within these plates. Muffler placed



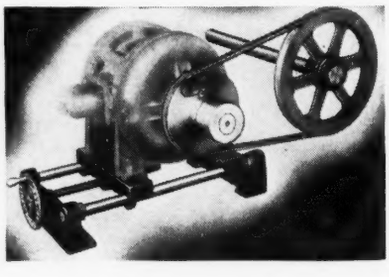
at end of arc chute serves to eliminate residual flame and reduces noise. Safety features of air-supply system include cut-off valves that automatically prevent discharge of air from system to faulty breaker, or from breaker tanks to leaky systems, and alarm valve which warns of leakage.

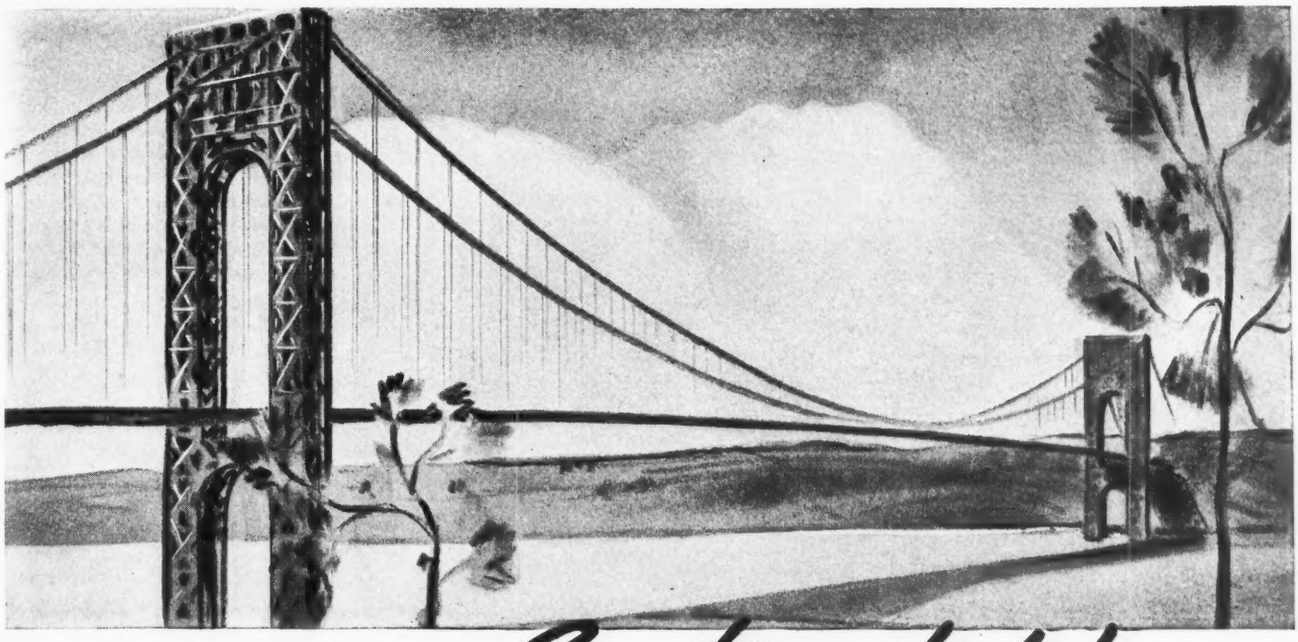
Westinghouse Electric & Mfg Co, East Pittsburgh, Pa.

Variable-Speed Control

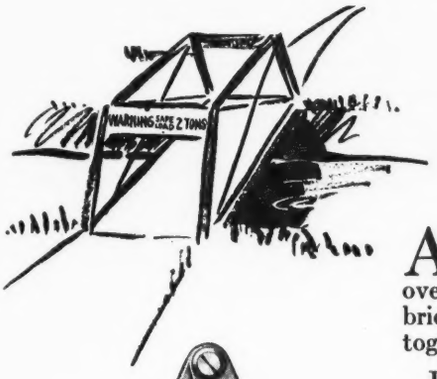
REEVES VARI-SPEED JR has been added to line. Unit consists of disk assembly and adjustable motor base. Disk assembly comprises two cone-shaped disks, one stationary and one laterally adjustable, a

(*Continued on page 154*)





Constructed for HEAVY DUTY



AN engineering masterpiece is the George Washington Bridge. Stretched across the Hudson River with a channel span of 3,500 feet, it handles over 20,000 heavy vehicles a day. Compare this with the ordinary country bridge. The small bridge may be adequate for its needs, but it would not hold together long under the heavy traffic of the George Washington Bridge.

Like the George Washington Bridge, GARLOCK 90 Waterproof Hydraulic Packing is also *constructed for heavy duty*. Manufactured from the longest fibre, imported roving, sorted and graded by flax experts and braided with extreme care, GARLOCK 90 is unusually strong and durable.

GARLOCK 90 is recommended for rams, accumulators, hydraulic pumps, elevator plungers or outside packed pumps handling cold water or cold oil. It gives long dependable service on all heavy-duty hydraulic jobs. All sizes from 1/8" to 3".

THE GARLOCK PACKING COMPANY, PALMYRA, NEW YORK

In Canada: The Garlock Packing Company of Canada Ltd., Montreal, Que.

GARLOCK 90

WATERPROOF HYDRAULIC FLAX PACKING

GARLOCK 90—Coil
GARLOCK 92—Spiral
GARLOCK 99—Ring

SEAL

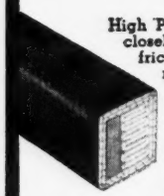
THAT STEAM!
PACK WITH BELMONT

Keep your pressure! Use a packing designed for high pressure steam service.

The packing illustrated above, Belmont 30, offers a unique center construction. Center block is pleated upon itself, accordion fashion, at an angle of approximately 90 degrees with the rod. This provides high resiliency—abundance of take-up on the gland, and ultimate "edge wear" (longer life) on the block.

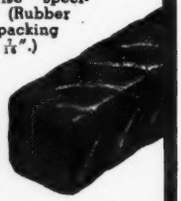
All Belmont packings are constructed to give maximum economical service under the most rigorous conditions. No matter for what service you buy a Belmont packing, you'll find it made with the same fine care and attention to detail that distinguishes Belmont 30. See the complete line of Belmont packings in the new 1940 catalog. A request on your company letterhead brings it absolutely FREE.

Suggested Belmont Packings For Steam Service



BELMONT 30

High Pressure Packing. Made of closely woven asbestos cloth frictioned with a heat-resisting rubber compound. Unique accordion-pleated center block. Rubber cushion remains resilient even under extreme temperatures. Comes lubricated and graphited unless otherwise specified. (Rubber cushion omitted in packing space sizes smaller than $\frac{1}{16}$".)



BELMONT 754

Square Braided Packing. Made of long fibre asbestos yarn, with a fine copper wire twisted with each strand. Braided, in same manner as square braided flax packings. Each strand of metallic yarn is thoroughly lubricated and graphited, resulting in a finished packing which lessens possibility of hardening in service.

THERE'S A BELMONT PACKING FOR EVERY SERVICE

BELMONT

PACKINGS

THE BELMONT PACKING & RUBBER COMPANY

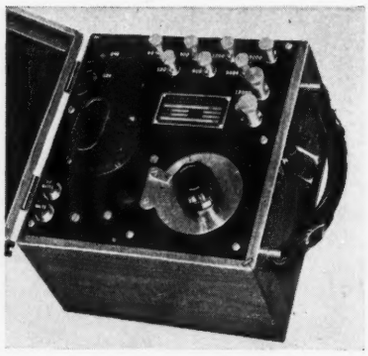
BUTLER AND SEPVIVA STREETS • PHILADELPHIA, PA.

self-adjusting tension spring, a spring adjusting nut and cover. By means of handwheel, motor is moved forward and back. When nearest to driven sheave, V-belt runs over largest diameter on disks and maximum speed is secured. Reversing handwheel moves motor away from driven sheave and V-belt runs over smaller diameter on disks, adjustable disk moving out to accommodate belt, and speed is reduced. Wide variety of speed available without jumps or steps, and speed can be changed without stopping machine.

Reeves Pulley Co, Columbus, Ind.

Load Analyzer

KNOPP ANALYZER provides in one instrument means for accurately measuring power factor of individual loads as small as 1 or 2 watts and of loads as large as 12,000 to 48,000 watts, depending on voltage range. Makers state that instrument is



suitable for measuring power factor on all sizes of fluorescent lighting equipment. For measuring very large amounts of power beyond range of instrument, analyzer can be used to advantage in secondary of metering transformers.

Electrical Facilities, Inc, 4224 Holden St, Oakland, Calif.

Lock Nut

SECURITY lock nut can be tightened up or backed off part way, according to maker, and still retain its grip on bolt. Bolt-gripping element consists of slightly elliptical-shaped spring-steel retainer permanently seated in head of a standard nut. When nut is applied, retainer is distorted from elliptical into circular shape, setting up powerful spring pressure between bolt threads and retainer threads.

Security Metal Products, Inc, 331 East Kalamazoo Av, Kalamazoo, Mich.

Pneumatic Systems

TAYLOR remote pneumatic transmission system utilizes standard Taylor instruments, and is useful in correlating temperature, pressure, flow or liquid-level data on a centralized panel or in a control room. It may consist of one or two transmitters connected to a receiver; or one or more receiving instruments, not necessarily near each other and as far as 1,000 ft

Philadelphia LIMITORQUE CONTROL operates all types of valves, etc., safely, economically, from convenient stations.
Philadelphia WORM GEAR SPEED REDUCER right angle drives—vertical or horizontal. Wide range of ratios and horsepowers.
Philadelphia HERRINGBONE SPEED REDUCER for heavy loads at high speed. Single, Double, Triple Reductions, various ratios and horsepowers.
Philadelphia MOTOREDUCER The economical self-contained drive. Horizontal or Vertical types—various ratios and horsepowers.
Philadelphia GEARS All types and sizes of industrial gears. Can be supplied in all materials.

● Yes, it's true, REAL ECONOMIES DO FOLLOW FROM THE USE OF LIMITORQUE VALVE CONTROLS. The savings that result when valves (up to 94" in diameter) are operated by pressing a button at a conveniently located control station, really mount up. Limitorque also protects the valve parts by automatically shutting off the motive power, whenever an obstacle is encountered.

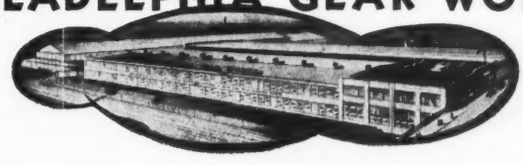
•

Limitorque is being adopted by more and more power plants, water works, sewage disposal plants and many others, from the Atlantic to the Pacific.

You can fit Limitorque to any type valve from 3" to 94" diameter, and to existing equipment if desired.

Write now for complete facts and figures.

PHILADELPHIA GEAR WORKS

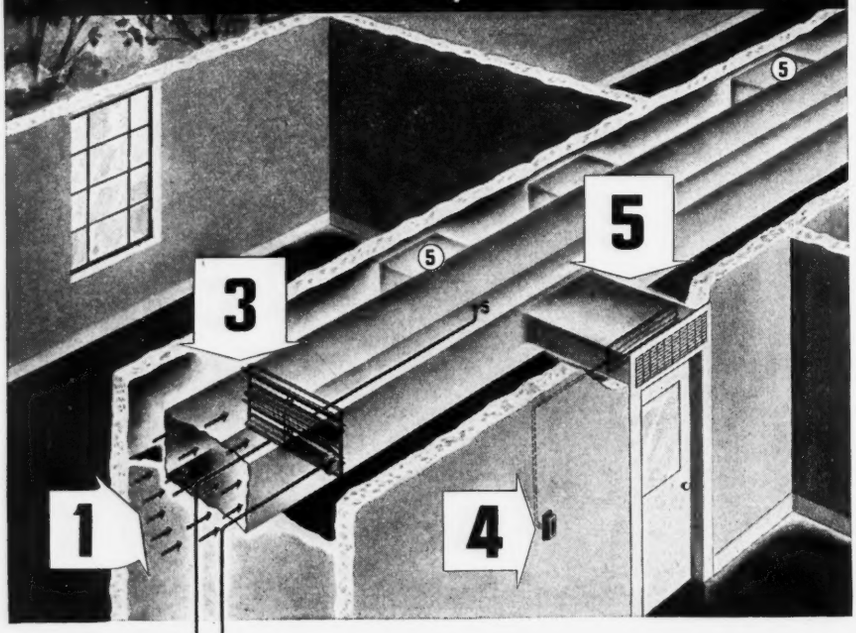


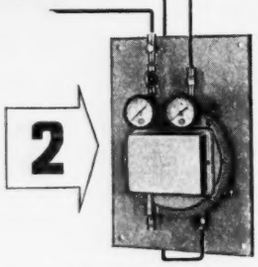
Limitorque Division
Erie Ave. and G St.
Philadelphia, Pa.

•

New York • Pittsburgh • Chicago

Maintain *Constant Static Pressure* in Delivery Ducts





with JOHNSON Static Pressure Regulator

1 Air for cooling or heating is delivered to a typical trunk duct by a central air conditioning system.

2 JOHNSON Static Pressure Regulator senses changes in resistance pressure in the duct, through its connection to static fitting "S."

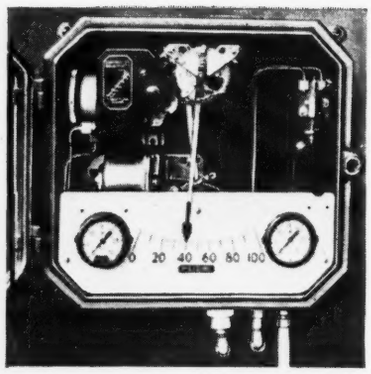
3 JOHNSON Proportioning Damper in delivery duct is operated by the Static Pressure Regulator to maintain uniform conditions.

4 JOHNSON Thermostat, in each room, controls a damper behind the register face, admits just the proper quantity of air.

5 Regardless of variations in requirements of individual outlets, the air-balance of the entire system is undisturbed.

Now, the problem of maintaining proper balance of conditions in a trunk duct is solved. No longer is it necessary to upset the entire air delivery system when dampers in individual outlets are operated, automatically or manually, to satisfy the temperature requirements of certain rooms . . . The JOHNSON Static Pressure Regulator senses just what is happening, all the way down the line. The exact resistance pressure, at which the system was balanced, and for which "splitters" were set, is maintained automatically. Johnson's *Adjustable Sensitivity* tunes the Regulator to fit the exact requirements of the particular installation. Send for descriptive bulletins.

JOHNSON
Automatic TEMPERATURE AND AIR CONDITIONING *Control*
JOHNSON SERVICE COMPANY, MILWAUKEE, WIS. AND DIRECT BRANCHES IN PRINCIPAL CITIES



from transmitter. Transmitters or receivers may be indicating, recording or controlling types. Air pressure is transmitting medium, with ¼-in. copper tubing as means of connection. Speed of response of receiver to changes in output air pressure is largely dependent upon distance, maximum lag being one second per hundred feet of connecting tubing.

Taylor Instrument Cos, Rochester, N. Y.

Scale Preventer

"K.A.T." is used to prevent and remove scale formations in water stills and evaporators, according to maker. It is said to prevent foaming and entrainment, and promote pure distillate. Also claimed to replace usual method of acid cracking, manual and sand-blast cleaning. Works with all waters and requires no chemical water analyses except to determine hardness.

American K.A.T. Corp, 122 East 42nd St, New York, N. Y.

Mercury Lamp Transformer

ADDED to line of present transformers, new unit is designed to operate two 400-watt mercury lamps. Indoor type is rectangular for wall or post mounting, with brackets for easy installation. Terminals are made accessible by small doors at top and bottom. Weatherproof pole-mounting units have terminals accessible at bottom; three threaded hubs included so that up to 3-fixture mounting supports may be used.

Jefferson Electric Co, Chicago, Ill.

Block Insulation

L-W SUPEREX is furnished in both block and pipe-covering form, and is suitable for use in industrial furnaces, flues, stack, etc, where insulation will be subjected to temperatures between 600 and 1500 deg F. Sectional form is intended for piping and headers within same temperature range.

Johns-Manville, 22 East 40th St, New York, N. Y.

V-Belt

BELIEVED to be first V-Belt made which prevents accumulation of static electricity, belt retains static-discharging qualities dur-

In 9 out of 10 cases a BARTLETT-SNOW Standard Coal Handling System Will Give You

More Equipment for Less Money

● Engineers recognize today that one or another of the Bartlett-Snow Standard Coal Handling Systems meets exactly the requirements of 90% of boiler plants rated from 1000 to 5000 H. P. Each system consists of track or other receiving hopper, a skip hoist, bunker, weigh larry, and even field storage and ash handling if desired . . . is adapted for installation in existing or new buildings, and can be altered to meet a variety of yard and track conditions. Each represents an actual installation of proven fitness for that size and type of plant, and since they incorporate the use of standard units, they minimize the charges for new enginering—and permit the maximum amount of the appropriation to be expended for actual machinery and plant facilities.

Bartlett-Snow's Coal Handling Systems are being used by consulting and company engineers alike in some of the best known concerns in the country. They have proven their efficiency. Complete details, including engineering diagrams, illustrations, etc., have been reproduced in a 48-page bulletin which will be sent on request to responsible engineers or company officials. It's free. Write for a copy of Bulletin No. 83 today.

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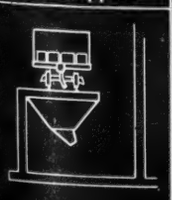
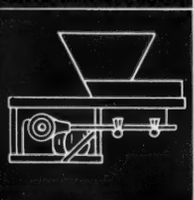
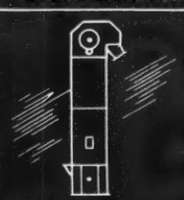
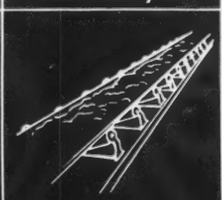
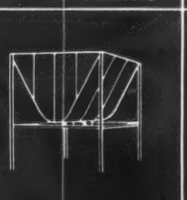
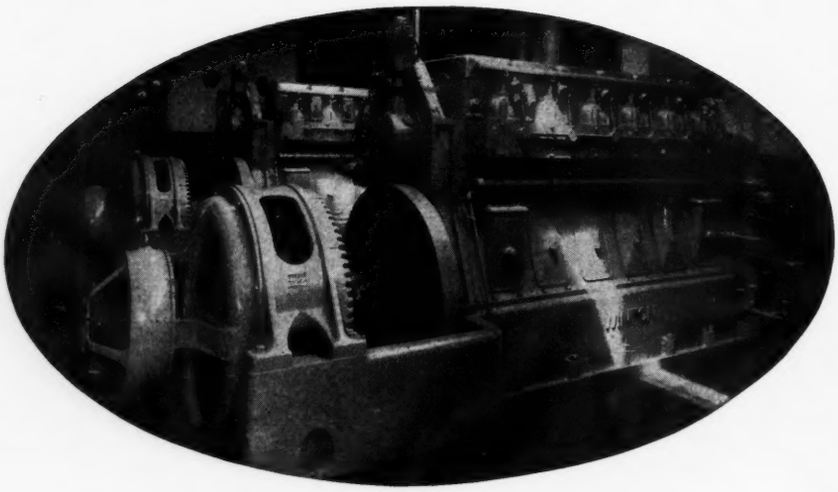
• • BOILER PLANT COAL HANDLING SYSTEMS • •

Complete Engineering and Fabricating Facilities to Meet Any Requirement Including

Track Hoppers	Gates and Feeders	Skip Hoists	Bucket Elevators	Belt Conveyors	Bins and Bunkers	Weigh Larries
						

SERVICE PROVED Lubricants Assure Dependable Performance



Trick oils may look impressive in short demonstrations, but if you want Diesel oils that will give dependable, consistent performance — every day — every week — every month — you will want an oil that has proved its worth. Not an experimental oil but one that has been service proved — a Cities Service oil, engineered for the job.

Experience has shown that no one oil will prove most effective and economical for a given make of engine under all conditions of operation. Such factors as power output, crankcase oil temperatures, etc., may as often as not make the use of a cheap oil expensive and an expensive oil cheap. Let one of our lubrication engineers tell you why — and prove it on your own equipment. Mail the coupon to us or write us on your own letterhead.

In any event you will benefit from reading a copy of our new booklet on "Diesel Engine Lubrication." Sent free to any user of Diesel engine oil.

CITIES SERVICE DIESEL LUBRICANTS

CITIES SERVICE OIL CO.
SIXTY WALL TOWER—Room 1626A,
NEW YORK, N. Y.

Please send me information concerning your Engineers' Lubrication Service (check box) ☐

Please send me folder on "Diesel Engine Lubrication" .....(check box) ☐

*Name*_____

*Firm Name*_____

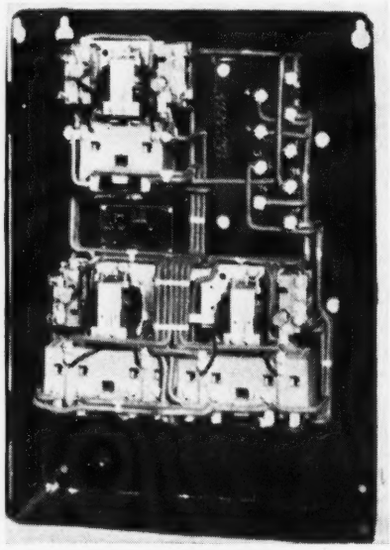
*Address*_____ *City*_____

ing entire service life. Belt will be sold, for present time, only to machine or equipment makers. Important feature of belt is absence, maker says, of any danger of belt acting as a "short" between motor and operator. Resistance built into belt is just enough so that belt itself cannot act as a direct passage for current.

B F Goodrich Co, Akron, Ohio

Magnetic Starter

DIFFERENT SPEEDS on across-the-line starters are obtained by changing motor connections to change its number of poles. Starters are available for constant horsepower, constant and variable torque, and single-



and double-winding motors. Features include pushbutton speed selection, accurate overload protection, low-voltage protection, "De-Ion" arc quenchers, and front-of-board wiring with accessible terminals.

Westinghouse Electric & Mfg Co, East Pittsburgh, Pa.

Current Regulator

TYPE Y-H constant-current regulator comprises regulator and controller-protector switch. Has no moving coils but operates from no load to full load, adjusting its output voltage to varying load conditions without surges on line or lamp circuit and is consequently adjusted instantaneously with changes in load. Due to extremely low current-draw, says maker, supply-line drop is small.

Wagner Electric Co, 6400 Plymouth Ave, St. Louis, Mo.

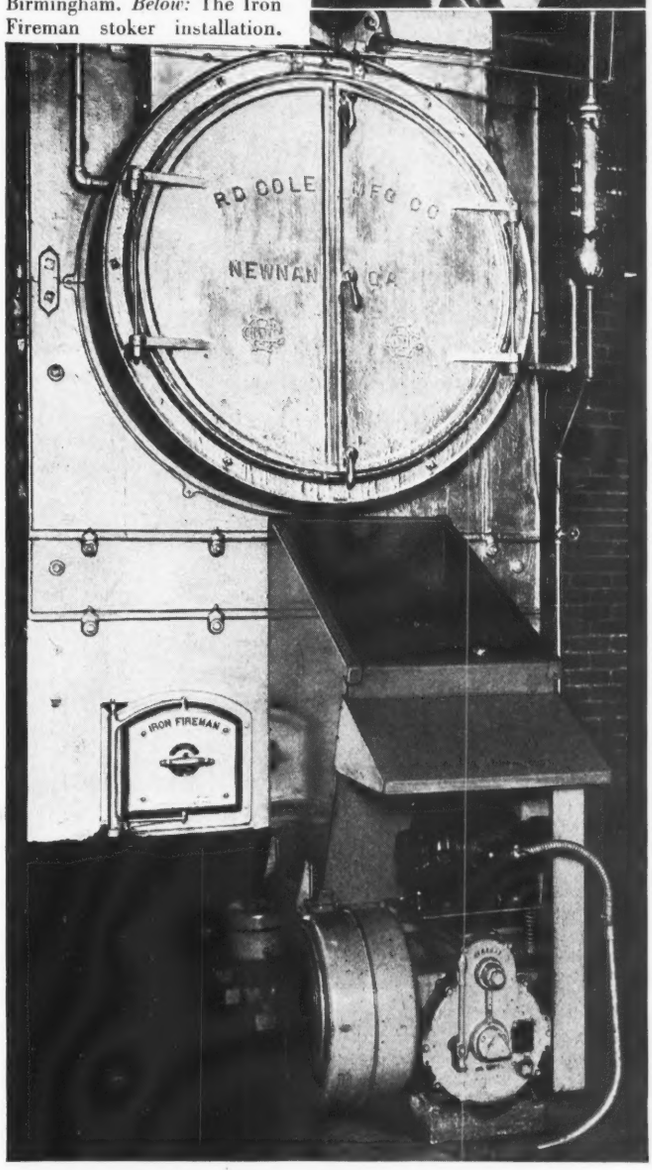
Silica Remover

PERMUTIT PROCESS for removing silica from boiler water makes use of silica-absorbing property of metallic oxide sludges. Water being treated is brought into intimate contact with high concentrations of sludge, thus assuring maximum silica removal. Process can be used with both hot and cold lime-soda processes of water soften-

IRON FIREMAN

Poweram Stoker Pays Dividends of 50% a Year in Alabama Boiler Plant

Right: G. Moseley, President of Family Service Laundry, Birmingham. *Below:* The Iron Fireman stoker installation.



The Family Service Laundry of Birmingham asked for an Iron Fireman engineering survey—primarily to determine means of abating a smoke nuisance. Our survey disclosed that Iron Fireman Poweram firing could not only do away with this smoke nuisance but, in addition, could make a big saving in fuel costs by firing certain low-cost coals.

On the basis of the survey, the laundry installed an Iron Fireman *Poweram* (which combines worm feed with ram distribution of coal) in its high pressure boiler. These are the results, as reported by President G. Moseley: The serious smoke complaint is entirely eliminated; lower-cost fuel is burned; cost per 1000 pounds of steam is reduced to 13.8 cents; labor costs are cut $1500 a year . . . with *all savings adding up to a 50% annual return on the original investment.*

Further, "uniform steam pressure, so essential in efficiently operating a laundry, is now obtainable for the first time," says Mr. Moseley.

What Other Investment Can Earn YOU So Much?

Let Us Make a Survey for YOU. How large a return can an investment in an Iron Fireman stoker earn in your plant? We can give you the answer, without cost or obligation on your part. Simply authorize us to make an engineering survey of your boiler plant. We invite the collaboration of your consulting engineer, or your plant engineer. The coupon is your invitation.

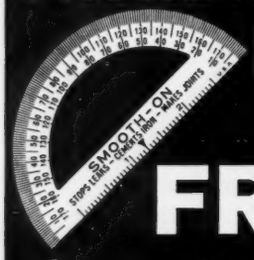
IRON FIREMAN
Automatic Coal Stokers

IRON FIREMAN MFG. Co., Portland, Ore.; Cleveland; Toronto.
Mail to 3379 West 106th Street, Cleveland, Ohio.
Please give us further information, without cost or obligation.

*Name*_____

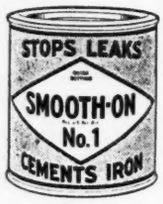
*Address*_____

PROTRACTOR-RULE sent FREE if you mail the coupon



This durable metal protractor is a handy help that every engineer and mechanic should have. It has black letters on a white background for greatest legibility, with angles reading in both directions, and has an inch scale on the straight side.

Another handy help which every engineer and mechanic should have is SMOOTH-ON No. 1. This many-purpose iron cement has been saving time, labor, and money on repair jobs for more than 45 years, and is a real necessity in every plant.



Some SMOOTH-ON uses:

REPAIRING CRACKS
in casings and shells of boilers, heaters, pumps, compressors, heat exchangers, process apparatus, piping, tanks, valves, etc.

STOPPING LEAKS
at seams, bolts, rivets, threaded or flanged joints, etc.

TIGHTENING LOOSE PARTS
of machines or apparatus, anchoring machinery to foundations or metal fixtures to metal, masonry or wood, etc.

SMOOTH-ON is easy to apply, requires no heat, dismantling of apparatus or special tools and makes an effective, lasting repair. The 40-page free Smooth-On Repair Handbook, which will be sent if you return the coupon, gives full instructions for dozens of ingenious repair jobs all around the plant.

Get SMOOTH-ON No. 1 in 7-oz., 1-lb. or 5-lb. can, or in 25-lb. or 100-lb. keg from your dealer, or if necessary from us. For your protection, insist on SMOOTH-ON, used by engineers and repair men since 1895.

SMOOTH-ON MFG. CO., Dept. 30P
570 Communipaw Ave., Jersey City, N. J.
Please send the free protractor and copy of Smooth-On Handbook.

Name .....

Address .....

.....

11-40

Do it with
SMOOTH-ON

ing and is adaptable to either new or existing equipment.

Permutit Co, 330 West 42nd St, New York, N. Y.

Fusible Boiler Plug

ROCKWOOD FUSIBLE PLUG is made of high grade bronze, with cores filled in with Banca tin. Plug may be conveniently removed, when either filled or fused, by hitting side with hammer, collapsing it. This disengages plug threads from boiler and plug can then be pulled out easily.

Rockwood Sprinkler Co, 38 Harlow St, Worcester, Mass.

Power Units

"SIMPAC" power units are self-contained ac generators, with integral exciters, instruments, voltage regulators and control. Said to be especially useful in outlying localities, or for specialized industrial applications where ac power is not readily available. Descriptive data 3808.

Westinghouse Electric & Mfg Co, East Pittsburgh, Pa.

Motor Starters

FURNISHED in sizes "0" and "1", units are designed for stopping, starting, and overload protection of single and polyphase motors up to 7½ hp. Feature of starter is automatic relatching mechanism said to eliminate any resetting operation. Operation is "handle free": an excessive overload will open circuit even though handle is intentionally held in "on" position. Quick-break positive toggle mechanism is designed so that vibration or shock will not cause contacts to open. It is mechanically impossible for contacts to close until "start" button has been pressed.

Colt's Patent Fire Arms Mfg Co, Hartford, Conn.

Midget Pump

MODEL E pump is companion to pump announced earlier in new equipment columns of POWER. This unit is adaptable to all installations requiring pumping of thin liquids where weight and space must be kept at minimum. Has maximum volume of 8 gals per minute, with maximum

Speed PRODUCTION with FRANCE METAL PACKING

Speed up the preparedness program. Install FRANCE Metal Packing and obtain maximum engine, pump and compressor service.

. . . Eliminate packing failures. The "full-floating" principle of France sectional metal rings in a metal case provides top efficiency under all conditions of temperature, pressure and speed.

. . . Prevent crankcase oil from escaping and condensation from entering the crankcase in numerous applications.

. . . Wide adaptability and downright economy. Installed in many of the largest plants in all parts of the world on steam, air and all types of gas units. A France Metal Packing installation means fewer shutdowns and less maintenance.

. . . Accurate records maintained for quick renewals or replacements.

. . . Nearly half a century of specialized experience.

. . . Prompt engineering service through experienced local representatives.

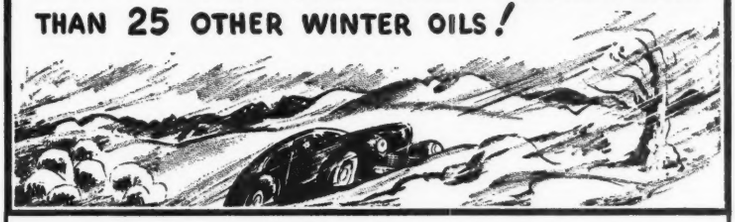
Help yourself to economy and faster production with FRANCE Metal Packing.

Write for Catalog M-7.

THE FRANCE PACKING COMPANY
Tacony, Philadelphia, Penna.
Branch Offices in Principal Cities

Original
FRANCE
METAL PACKING

WINTER **RING-FREE** POURS AT 20° BELOW ZERO... YET CERTIFIED WINTER TESTS HAVE PROVED IT'S SO TOUGH AND OILY IT DELIVERS **11.4 MORE HORSEPOWER** THAN 25 OTHER WINTER OILS!



THE U.S. IS THE ONLY COUNTRY IN THE WORLD WHERE IT WOULD BE POSSIBLE FOR EVERY MAN, WOMAN AND CHILD TO RIDE IN A MOTOR VEHICLE AT ONE TIME!

*Believe it or not!** **Otto Abshier Trucking Co., Indianapolis,** who operates both gasoline and diesel trailer trucks the year 'round, says: "My operation is a fast schedule between Louisville, Indianapolis and Chicago covering 650 miles every day. I am enclosing photograph of the pistons taken just as they were pulled out ... the rings ... are the original set, having gone over 114,000 miles ... in very good condition. The total wear on pistons and sleeves combined was only .0045. I appreciate this outstanding performance on Ring-Free and wish to congratulate you on your fine product."

*Believe it or not!** **O. E. Jones, Paducah, Ky.,** says: "I have never seen an oil that will equal the performance of Ring-Free Motor Oil in tractors and autos."

*Believe it or not!** **Grace Drilling Company, Stamford, Texas,** who use Ring-Free in both Buda Diesel and Buda Gas engines say: "Prior to using Ring-Free we had a great deal of trouble with rings sticking and gumming up ... since using Ring-Free we have not had this trouble. We run the diesel motors about 175 to 200 hours before draining ... and then find the oil still has a good body. We are well pleased with the results it has given in both."

*Reg. U. S. Patent Office

Gasoline or diesel ... winter or summer ... it's all the same to Ring-Free! But Ring-Free makes a world of difference in winter diesel operation. For, Believe It or Not!* lighter grades of Ring-Free have practically all the film strength of Ring-Free in the heavier grades ... even at high diesel temperatures! This means more power; less wear and less cost for spring repairs. Proof? Call the Macmillan Man ... or write us direct.

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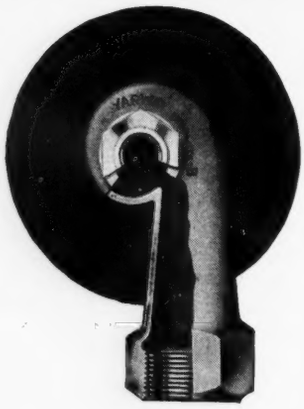
MACMILLAN PETROLEUM CORPORATION

50 WEST 50TH STREET, NEW YORK • 624 SOUTH MICHIGAN AVENUE, CHICAGO • 530 WEST 6TH STREET, LOS ANGELES

YARWAY INVOLUTE SPRAY NOZZLES



Unique Yarway Involute design.

No internal parts or vanes to clog or erode.

Unobstructed flow gives minimum loss of head.

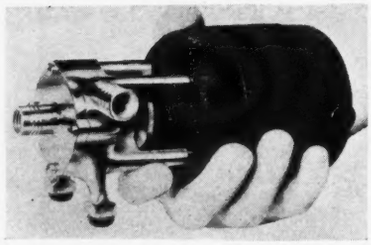
Finely divided spray cone provides rapid cooling.

Renewable orifices adapt nozzles for any service.

Installations total more than 5 million gallons per minute in water cooling and air conditioning service.

Made in both cast and bar-stock types. All sizes from ¼ in. to 2½ in. Write for Catalog N-615.

YARNALL-WARING COMPANY
100 Mermaid Ave. Philadelphia



pressure of 20-25 lb psi. Pump weighs 6 lb, and is driven by Universal, heavy-duty, fan-cooled, 1/20-hp motor.

Eastern Engineering Co, 45 Fox St, New Haven, Conn.

Floor Dye

ENAMEL-LIKE floor dye (Colorflex) has been made fire- and acid-proof. Test made shows that gloss is not injured even when alcohol is poured on dye and flame applied, or when sample is dipped in acids of various types. Comes in four colors: tile red, emerald green, linoleum brown, and battleship gray.

Flexrock Co, 23rd & Manning, Philadelphia, Pa.

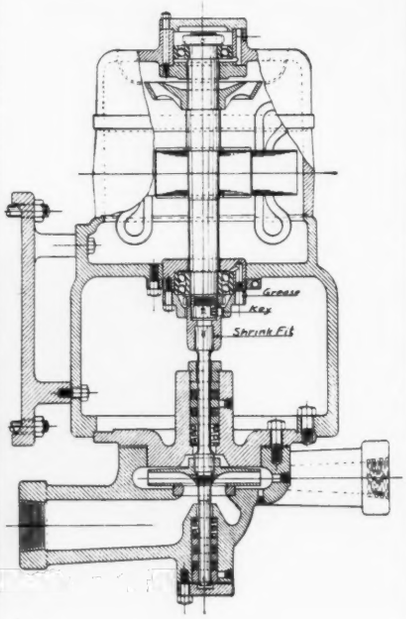
Pulley Facing

POWERLOX is synthetic leather paste used to coat pulleys and eliminate belt slippage. Compound is said to be impervious to effects of oil, grease, gases, acid, dust, frost, and heat. Only necessary to clean pulley and apply compound with applicator supplied.

Powerlox Mfg Co, 507 Fifth Ave, New York, N. Y.

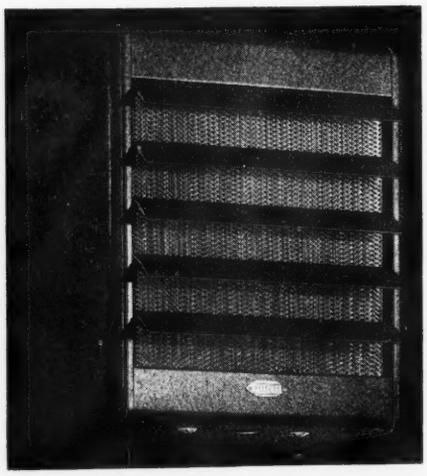
Centrifugal Pump

FEATURE of centrifugal pump is small, stainless, hardened shaft, separable from motor shaft, extended through impeller to water-lubricated bearing. End thrust is



Built for men who
APPRECIATE GOOD DESIGN

Fedders SERIES 4 UNIT HEATERS



1. STREAMLINE TUBES with individual non-clogging fins relieve differential expansion stresses between adjacent tubes.
2. FULL FLOATING protection against expansion stresses between heating element and cabinet.
3. MONO-PIECE CABINETS combine strength, rigidity and handsome appearance for commercial and industrial uses.
4. HEADERS are of large internal area for uniform steam distribution.
5. MOTORS are mounted in rubber to isolate vibration.

Write for Catalog 573.

FEDDERS
MANUFACTURING CO., INC.
Air Conditioning Division
63 Tonawanda St. Buffalo, N. Y.
Representatives in All Principal Cities

STRETCH THE STEAM CAPACITY OF YOUR PRESENT BOILERS

a preparedness "Must"

You can do it with HAYS Automatic Combustion Control

Hays Automatic Combustion Control in the plant of an eastern manufacturer of electrical instruments.

HAYS AUTOMATIC COMBUSTION CONTROL stretches your steam capacity because the air and fuel rates are kept in accurate proportion to each other and in direct relation to the plant load.

This permits the operation of your boilers closer to their maximum capacity with a greater degree of safety and economy than possible under manual operation.

The industrial power plant plays a vital part in the nation's defense program. This is especially true in the process industry. "Whether it makes its own electricity or buys it from an inexhaustible source, the process industrial must shut down if steam fails" says a prominent industrialist.

So — look to your power plant! Be sure you can operate each boiler when necessary at peak capacity — with SAFETY and ECONOMY. *You can do it with Hays Automatic Combustion Control.*

There is a Hays engineer-representative in your vicinity ready to consult with you on cost and other details — his name can be found in your telephone directory or we will send it upon request.

The HAYS CORPORATION
SINCE 1901 COMBUSTION INSTRUMENTS AND CONTROL
MICHIGAN CITY, INDIANA, U.S.A

Send for this new booklet just off the press "Automatic Combustion Control and Its Relation to Lower Steam Costs"

Individual.....

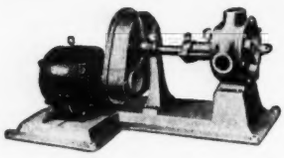
Firm Name.....

Address.....

905

Put Your
HEADACHE
in an
ENVELOPE

Viking makes no claim to be a "cure-all"—but headaches caused by constant pumping worries are right down its alley. Many a production manager has secured quick, lasting relief by simply installing dependable Viking Rotary Pumps. With only 2 moving parts, Viking lasts longer, requires less power, is easier to service, demands less servicing. If your pumps have made you a chronic sufferer, we suggest you put your problem in an envelope and mail it to Viking. We'll fire back Bulletin 1802-35, which you'll find is a splendid "first aid kit" for a surprising number of pumping worries.



LOOK FOR THIS TRADE MARK THE SIGN OF A GENUINE VIKING

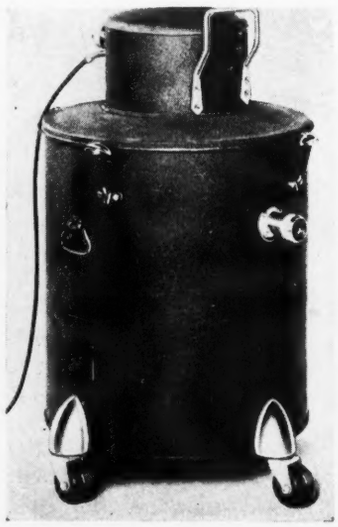
VIKING PUMP CO.
CEDAR FALLS, IOWA

carried by double-row ball bearing, which is so mounted that end-wise adjustment of shaft is provided, to take up wear on wearing ring on suction side of impeller. Pump shown has closed impeller, but unit can be furnished with open type if desired. Pump has been tested with packing holding 1200 lb per sq in. pressure, and at corresponding steam temperature.

Condenser Cleaners Mfg Co, 530 First Ave, Pittsburgh, Pa.

Vacuum Cleaner

PREMIER INDUSTRIAL CLEANER has 1-hp motor, and one bushel capacity, with streamlined bodies for easy portability. All types



of cleaning tools are available for use with unit, and maker states that cleaner requires practically no attention.

Electric Vacuum Cleaner Co, Ivanhoe Rd, Cleveland, Ohio

Sealing Compound

KEY paste is graphite sealing compound for thread and gasket connections on lines carrying oily liquids and high-pressure steam. Paste expands when heated and requires only water for thinning. Joints made up with paste are easily disconnected without damage to threads or gaskets.

Key Co, 2633 McCasland Ave, East St. Louis, Ill.

Power Lines

(*Continued from page 136*)

gineers, J E Sirrine & Co, Greenville, S. C., who prepared the plans: Coal-handling equipment and coal silo to the Fairfield Engineering Co, Marion, Ohio; automatic coal scales to Richardson Scale Co, Clifton, N. J.; ash-handling equipment to United Conveyor Corp, Chicago, Ill.; automatic combustion control and plant meters to Bailey Meter Co, Cleveland Ohio

This boiler plant extension, approxi-

SILICA REMOVED FROM BOILER FEED WATER WITH FERRISUL

One of the most perplexing problems in conditioning natural water for boiler feed purposes is the removal of silica. Some coagulants, effective for silica removal, have a tendency to cause corrosion or scaling. With Ferrisul, these disadvantages are effectively and efficiently overcome.

Ferrisul (anhydrous ferric sulfate) has proved its superiority as a safe and dependable coagulant in boiler feed water because of its extremely absorptive floc and its effectiveness under varying conditions of water temperature, alkalinity and pH. This quick-forming, rapid settling floc removes organic matter and oily substances as well as silica, prevents scale formation and keeps total solids at a minimum.

The *new* Ferrisul booklet gives complete information on the use of Ferrisul for treatment of water, sewage and industrial wastes. Write for your copy today—there's no obligation. MONSANTO CHEMICAL COMPANY, Merrimac Division, Everett Station, Boston, Massachusetts.

FERRISUL
For treatment of
Sewage and Industrial Waste

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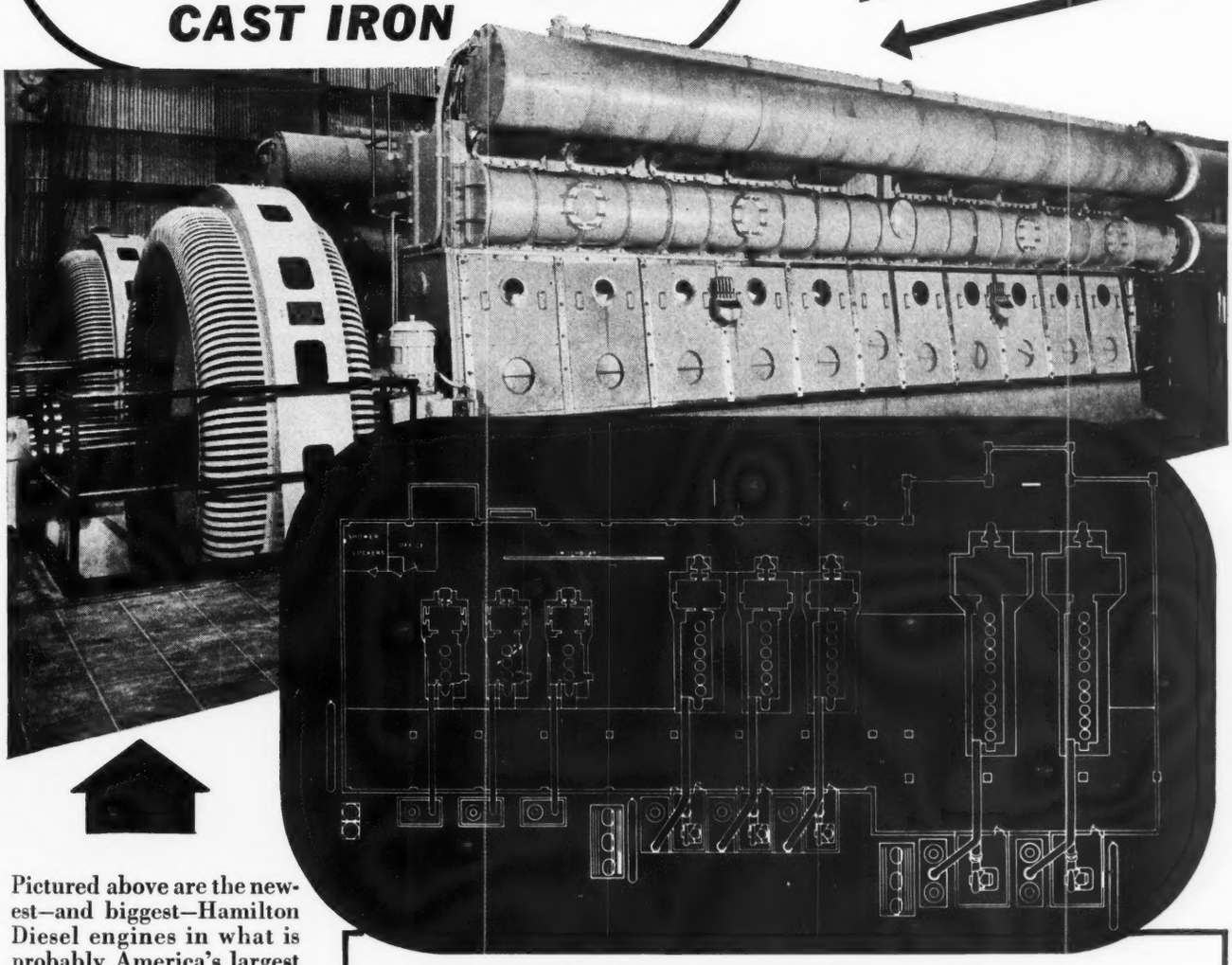
SERVING INDUSTRY... WHICH SERVES MANKIND

LONG-LIVED

NICKEL

CAST IRON

ALL 47 cylinders SHOW LOW RATE OF WEAR



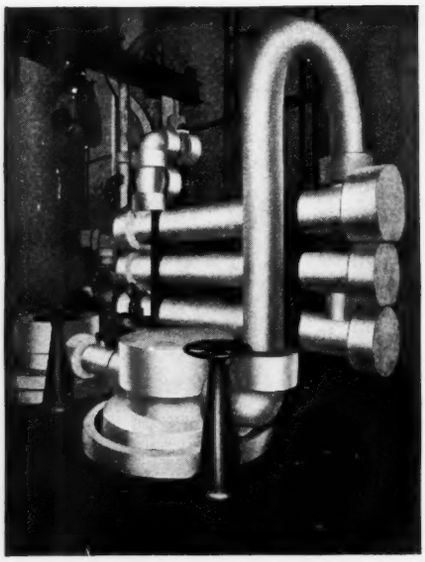
Pictured above are the newest—and biggest—Hamilton Diesel engines in what is probably America's largest Diesel plant, the Imperial Irrigation District at Brawley, California. The General Machinery Corporation says, "To obtain added wearing qualities and strength, we specify 1.75% Nickel, 0.50% chromium cast iron cylinder liners in these and similar units." The uniformly fine grain structure of Nickel cast iron assures improved wear resistance and accordingly maintains high unit efficiency and low maintenance costs.

Diagrammatic layout of Brawley plant showing the eight Hamilton Diesel engines with a total rating of 18,340 HP. This very efficient Imperial irrigation plant is capable of generating 12,000 KW with its forty-seven 21½" x 27½" cylinders.

Unusual maintenance economies have been made possible through standardization on unit sizes and materials. One of the substantial yearly savings is from the low rate of wear on the Nickel-chromium cast iron cylinder liners.

For units in your plant that must withstand heat, cold, abrasion, shock stresses or corrosives, there are suitable ferrous and non-ferrous alloys strengthened and toughened by additions of Nickel. For practical information, without obligation, please address:

THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK, N. Y.



A COLD BOILER pays NO DIVIDENDS

Every engineer knows that! Yet, each day thousands of dollars are lost in plants all over the country due to unnecessary boiler shutdowns.

Why not insure steady, uninterrupted service in your plant by installing

HENSZEY CONTINUOUS BLOWDOWN

Check These **Advantages**

- **Saves up to 95% of the heat ordinarily lost with intermittent blowdown.**
- **Produces clean steam—no carry over.**
- **Prevents Priming and Foaming.**
- **Prevents scale — with simple chemical treatment.**
- **Automatically controls Boiler Water Concentration.**
- **Indicates and Meters Blowdown.**
- **Practical for any size plant—large or small.**

We will gladly make an analysis of the boiler water problems of your plant to show you what savings can be made by proper boiler water concentration control. Remember Henszey can furnish you with *any* type of system.

Send for Literature

HENSZEY COMPANY
Dept. D-11 Watertown, Wis.

HENSZEY
BOILER WATER CONCENTRATION CONTROL SYSTEMS

mately 55 ft square, is part of the Erwin Cotton Mills' modernization program, involving over $100,000. It will include building changes, boiler replacements, stokers, and auxiliaries. Wm Muirhead Construction Co, also of Durham, has the building contract.

Diesel Engineers Assn Elects Officers for 1940-41

The Diesel Engineers International Association, 576 Newark Avenue, Jersey City, N. J., has elected the following officers for 1940-41 term:

President, Fred C Congdon; First vice-president: Dennis A McCarthy; second vice-president: Alfred Bohrer Krest; general secretary-treasurer: Julius Rosbloom.

Members elected on the National Technical Advisory Board are as follows: M J Dowd, chief engineer and general supt, Imperial Irrigation District, Imperial, California. F K Vance, supt and chief engineer, Water & Electric Dept, City of Neodesha, Kansas. Clint Voorhees, supt and chief engineer, Public Works, City of Dowagiac, Michigan. W E Ralls, supt and chief engineer, Municipal Utilities, City of Trenton, Missouri.

Thomas Moore, plant supt, Shenandoah Valley Electric Cooperative, Dayton, Virginia. R E Doonan, chief engineer and supt, Municipal Diesel Utilities, City of Waverly, Iowa. Elmer Davenport, chief engineer, Diesel Power System, McMinnville, Oregon. Bruce B Watts, chief engineer and supt, Municipal Utilities, City of Corning, Iowa. Roy E Boling, chief engineer and supt, Diesel Light and Power System, City of Pleasant Hill, Missouri. W J Dettman, chief engineer, Diesel Power Plant, City of Rochelle, Illinois. G J Woodhouse, chief engineer and supt, Municipal Utilities, City of Harlan, Iowa. D R Calhoun, Philadelphia, Pa.

Welding Society Discusses Carbon-Moly Piping

Among the papers presented at the 21st Annual Meeting of the American Welding Society, October 21-25, Cleveland, Ohio, was "The Welding of Carbon-Molybdenum Piping for High-Temperature, High-Pressure Service", by R W Emerson, Pittsburgh Piping & Equipment Co.

The article may be summed up with the following conclusions: Carbon-molybdenum steel is welded using an electrode of the same approximate analysis as the base material; for this reason, the main metallurgical consideration is the effect of the welding heat, followed by rapid cooling, on the hardness and microstructure of the base metal and weld deposit.

Hardness readings and microstructure examinations on a single bead weld made under severe cooling conditions indicates that the weld-hardening tendencies of low-carbon—½% molybdenum steel is only slight.

The above conclusion was also confirmed by heat-treating small laboratory specimens, it being necessary to water quench these specimens from 1925 F in order to produce severe hardening. Air cooling

(*Continued on page 172*)

HENSZEY
BOILER FEED REGULATORS

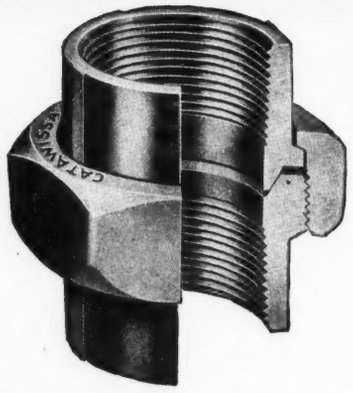
The Henszey Boiler Feed Regulator controls boiler water levels continuously and accurately under *all* load conditions!

These simple, compact, self-contained units go right in the feed line and require no additional structural support. They are as easy to install as a simple gate or globe valve. Once installed and set for operation no further attention is necessary — nothing to get out of order — nothing to reset.

Send for latest Bulletin containing full details.

HENSZEY COMPANY
Dept. D11—Watertown, Wis.

CATAWISSA



STANDARD UNIONS
Hot Forged From Solid Steel Bars

The forging process further refines the steel in Catawissa Unions and enables them to withstand years of shock and vibration. Seats, Steel to Steel, STAINLESS STEEL to Steel or Bronze to Steel are carefully hand ground, require no packing and are set on a 55° angle with a flat surface contacting a ball surface. This insures a perfect seal even though pipe is out of line . . . . Write for complete data and prices.

THE CENTRAL FORGING CO.
CATAWISSA, PENNA.

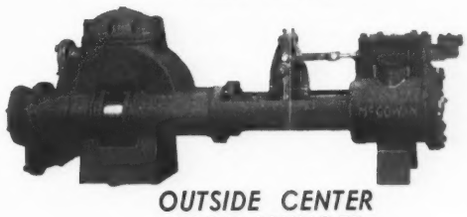
RUGGED

HE HAS TO BE — to stand up under terrific demands. McGowan Pumps too are Rugged, are built to stand up under severe conditions. Strongly built, for enduring performance, McGowan Pumps will meet your exacting conditions, give the ultimate in performance. McGowan Pumps have those rugged qualities that have made the name of McGowan famous since 1852.

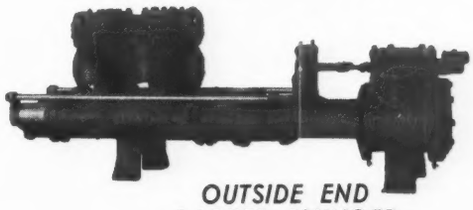
The experienced members of the engineering staff of the McGowan Pump Division are always pleased to furnish complete information on installation of Centrifugal, Reciprocating, and Deep Well Turbine Pumps. McGowan Pumps are available in pressures and capacities to meet conditions.

We illustrate 3 pumps from our new catalogue just off the press. Your request for this free catalogue of McGowan Pumps will receive prompt attention—Address Leyman Manufacturing Corporation, John H. McGowan Company Division, 54-58 Central Avenue, Cincinnati, Ohio.

PACKED PISTON VALVE PLATE



OUTSIDE CENTER PACK PLUNGER



OUTSIDE END PACKED PLUNGER

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New Bulletins

BOILERS AND ACCESSORIES

1 STOKERS—Whiting Corp, Harvey, Ill. 12-page bulletin No. 222 describes Whiting stokers, lists advantages, users' recommendations and experiences. Line drawings show principle of operation, and photographs show types.

2 FIREBRICK—Armstrong Cork Co, Lancaster, Pa. 8-page booklet describes insulating firebrick for all types of heated equipment. Specifications for applying given, and chief characteristics of different brands presented.

3 FIREBRICK CEMENT—Armstrong Cork Co, Lancaster, Pa. 6-page booklet describes Armstrong cements for laying and facing insulating firebrick. Different types of cements described for various applications. Tables show chief characteristics of cements and firebrick.

4 STEAM SCRUBBER—Bradshaw & Co, 530 Fourth Ave, Pittsburgh, Pa. 8-page bulletin describes W-K-M master steam scrubber. Purposes of scrubber are given, design presented, and questions and answers are asked and answered concerning operation and capacities of scrubber.

5 ASBESTOS—Keasbey & Mattison Co, Ambler, Pa. "Legends of Asbestos" is accumulation of stories about asbestos carried down from early times. Included are "Marco Polo's Salamander," "Charlemagne's Tablecloth," and others.

6 DUST COLLECTORS—Buell Engineering Co, 70 Pine St, New York, N. Y. 24-page booklet on "Dust in Industry" is in two sections. Section one has general information on dust collection; section two deals specifically with Van Tongeren Theory and its advantages.

7 BONDING MORTAR—A P Green Fire Brick Co, Mexico, Mo. 4-page bulletin gives advantages of "Sairset," air-setting, high-temperature bonding mortar. Comparisons between this and other mortars illustrated.

8 BOILER-FEED SYSTEMS — Micro-Westco, Inc, Bettendorf, Iowa. 4-page folder illustrates and describes Westco automatic boiler-feed systems, in sizes up to 25 hp and 125 lb pressure. Accessory equipment for boiler systems also listed.

9 DUST COLLECTOR—American Foundry Equipment Co, Mishawaka, Ind. Circular No. 42 describes American Assembled Type "Dustube" dust collector.

10 DEAERATING HEATER—Permutit Co, 330 West 42nd St, New York, N. Y. Bulletin No. 2357 briefly describes history of development of deaerating heaters, presents causes of corrosion of boilers and piping, and methods for preventing such corrosion.

11 CO_2 INDICATOR—Bacharach Industrial Instrument Co, 7000 Bennett St, Pittsburgh, Pa. Picture series illustrates operation of "Fyrite" indicator. Advantages listed and testimonials offered. Bulletin 337.

ELECTRICAL EQUIPMENT

12 CIRCUIT BREAKER—Roller-Smith Co, 1766 West Market St, Bethlehem, Pa. Catalog 1230 illustrates and describes low-voltage metal-enclosed air-circuit-breaker switch-gear. Shows different positions of switch-gear, such as operating position, test position, and fully-withdrawn position.

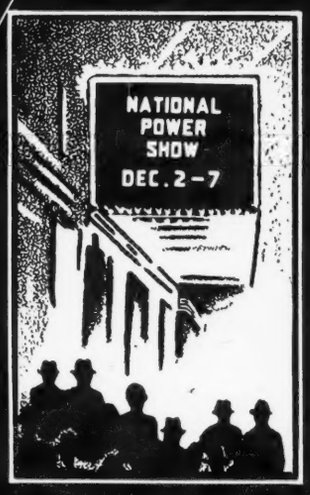
13 CONNECTORS—Burndy Engrg Co, 459 East 133rd St, New York, N. Y. Catalog No. 41 contains additional complete engineering data on electrical contactors. Photographs of unusual installations included.

AIR CONDITIONING & REFRIGERATION

14 AIR CONDITIONING—National Association of Fan Manufacturers, General Motors Bldg, Detroit, Mich.

MODERN POWER FACILITIES

For Preparedness, Peace and Prosperity



NOW, more than ever before, every industry of this Nation needs adequate, modern power facilities. Our vital defense program demands the utmost capacity to produce armament and equipment. This is an added responsibility superimposed on that of providing for the normal activities of our 131-million people. Only with ample, economical and reliable power can our industrial system meet its obligations and opportunities.

The immediate need for quickly preparing the Nation's power resources, raises this year's National Power Show to a new pinnacle of importance. Attendance becomes more than an opportunity and a privilege. Seeing the exhibits at this year's Power Show becomes a duty that every responsible engineer owes to his Country, his profession, his employers, his dependents and himself.

Whether your plant is producing goods of war or of peace—steel for shells or for housing and transportation; textiles for uniforms or civilian wear; food products, cosmetics, or paper for school books—come to the Power Show! See engineering's newest and finest aids to the generation and use of power for preparedness, peace and prosperity.

14th NATIONAL EXPOSITION OF POWER AND MECHANICAL ENGINEERING . .

GRAND CENTRAL PALACE · NEW YORK · DEC. 2-7, 1940

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are the solution to a wide variety of speed-measuring problems, as well as for indicating rates of vibration. Types for permanent mounting as well as for hand use.

Write for descriptive Bulletin 1590-P.

JAMES G. BIDDLE CO. 1211-13 ARCH STREET PHILADELPHIA, PA.

PUMPS

50 ROTARY PUMPS—Viking Pump Co, Cedar Falls, Iowa. Bulletin 2500-40 illustrates and describes new line of Viking rotary pumps for heavy-duty service. Outstanding features are listed and illustrated.

51 PUMPS—De Laval Steam Turbine Co, Trenton, N. J. Catalog L-32-A illustrates and describes De Laval-IMO oil pumps, designed for handling various grades of fuel oils, heavy crude oils, lubricating and hydraulic oils in capacities above 30 gpm.

52 PUMPS—Fairbanks, Morse & Co, 600 South Michigan Ave, Chicago, Ill. 16-page bulletin No. 5710 illustrates and describes new line of "Angleflow" pumps in both vertical and horizontal types in which hydraulic stream flow through impeller is at an angle to axis of rotation.

WATER TREATMENT

53 SCALE AND RUST REMOVAL—Oakite Products, Inc, 22 Thames St, New York, N. Y. Third edition 20-page booklet describes Oakite Compound No. 32 for safely removing water scale and rust from lube-oil and jacket-water coolers, feed-water heaters, surface condensers, diesel and gas-engine cooling systems, and compressors.

54 BOILER-WATER TESTING—W H & L D Betz, 235 W Wyoming Ave, Philadelphia, Pa. 16-page booklet, "How to Run a Control Water Analysis", reprints series of five articles from POWER on "How to Run a Water Analysis", "How to Test for Hardness", "How to Test for Alkalinity", "How to Test for Phosphates", and "How to Test for Chlorides". Photos show exactly how to perform each operation and text gives operator information necessary to calculate results; other pages list data on equipment used.

55 SILICA REMOVAL—Permutit Co, 330 West 42nd St, New York, N. Y. 8-page bulletin No. 2377 describes low-cost process, "Mag-de-Sil", for silica removal, without appreciable increase in total dissolved solids. Bulletin is summary of high points of research program made by company.

56 WATER CONDITIONING — Elgin Softener Corp, Elgin, Ill. 16-page booklet entitled "The Inside Story of Boiler Water Conditioning", explains wide variations in boiler-feed waters and operating conditions; how impurities accumulate inside a boiler and how they can be eliminated; explains four essentials of boiler-water conditioning; and tells how to maintain ideal boiler-water conditions inside a boiler by using correct treating and conditioning system.

WELDING

57 FLAME-HARDENING EQUIPMENT—Air Reduction Co, 60 East 42nd St., New York, N. Y. 10-page booklet makes available details on considerations and apparatus involved in flame-hardening surfaces of various forms. Descibes specifically Airco style 4383 water-cooled flame-hardening torch and variety of extensions and tips available for use with it.

58 WELDING—Hobart Bros Co, Troy, Ohio. 4-page folder describes Hobart simplified arc welder, showing features and users' reports of profits and savings.

59 ACETYLENE GENERATORS — Marquette Mfg Co, Minneapolis, Minn. Catalog-page tells advantages of acetylene generator as compared with acetylene cylinder service, and also describes portable acetylene generator.

OTHER EQUIPMENT

60 OILERS—Trico Fuse Mfg Co, Milwaukee, Wis. 4-page bulletin concerns Trico unbreakable wick-feed oilers. Types LA, LB, LC, LD included. Brief descriptions of each type presented, together with photo of oiler, and table listing dimensions. General information on all types of oilers included.

(Continued on page 174)

SEAT AND DISC: 500 BRINNELL
Full plug type Stainless Steel seat and disc heat treated to 500 Brinnell hardness to prevent galling. Precision machined to give full bearing.
STEM: HIGH STRENGTH ROLLED BRONZE
Provides high resistance to corrosion to match the body of high strength bronze that resists distortion under continuous service at maximum ratings.
P&C CO.

READING-PRATT & CADY FIG. 531-P
Union Bonnet, Full plug type, Bronze Globe Valve for heavy duty and severe throttling conditions to 350 lbs. steam and 550° F.

To Cut Maintenance Costs
OF VALVES IN AUXILIARY STEAM LINES

● The qualities you want in valves for your auxiliary steam lines have been engineered into the **531-P** for you. . . . Note that the full plug type seat and disc are of stainless steel—heat-treated to **500 Brinell hardness** to prevent galling—precision machined to have full bearing. . . . Note that you will have less trouble with body distortion even under continuous operation at maximum temperatures. Note that you will have less trouble with stem corrosion. . . . In fact, the entire make-up of **531-P** promises you long service free from maintenance. Write for complete information and recommendations.

READING-PRATT & CADY
DIVISION · · READING, PENNSYLVANIA

AMERICAN CHAIN & CABLE COMPANY, Inc.

For Defense You Can Depend upon

At flying fields, in camps, munitions plants, food factories, and on naval and transport ships, thousands of Frick cooling systems helped America win in 1917-18.

Today, refrigerating, ice-making and air conditioning equipment plays a still more important part. The food industries use "cold" as never before. Quick-frozen foods are stored by the millions of pounds. Frick machines are even installed in several U. S. submarines.

Wherever the greatest reliability and cooling capacity are needed, you can depend on Frick Refrigeration. Write for estimates.

TRADE FRICK MARK

FRICK COMPANY, Waynesboro, Penna.

Dependable Refrigeration since 1882.

Refrigeration

SABOTAGE!

Don't let inferior packing sabotage your rods, valves, flanges and joints. Frequent shutdowns for replacements are a form of sabotage . . . the slowing of essential production. Safeguard against unnecessary interruptions by using the longest wearing packing you can find. Alert engineers will be interested to know that

More Than 90%

of the engineers who have asked for and tested working samples of our packings have become permanent users. Your free sample is waiting for you. Send for it today specifying service and size.

GREENE, TWEED & CO.

SELF-LUBRICATING & SHEET PACKINGS

101 Park Ave., New York, N. Y.

ESTABLISHED 1863

PALMETTO

PACKING

61 NON-SLIP FLOOR WAX—Flexrock Co, 23rd & Manning, Philadelphia, Pa. Literature describes non-slip floor wax, Carnauba product processed with Neoprene. Also contains details of trial offer for prospective users.

62 LUBRICATION — New Departure Div, General Motors Corp, Bristol, Conn. 15-page booklet is presented as aid to choice of correct lubricants for ball bearings. Presents simple method of determining proper grade and viscosity of oil for various operating temperatures and bearing speeds.

63 FILTER—S G Frantz Co, 161 Grand St, New York, N. Y. 4-page folder describes engineering principles of filter which removes magnetically iron and steel particles from suspension in liquids. Sizes and types listed, as well as numerous uses for same.

64 PAINTING—American Marietta Co, Chicago, Ill. 120-page maintenance painting handbook gives general and specific information concerning various surfaces which may be painted; includes discussion on conditions for painting, and lists, with characteristics, different Valdura paint products.

65 ROOFING—Porcelain Steels, Inc, Cleveland, Ohio. 4-page bulletin describes Por-Ce-Lok, porcelain-enameled roofing and siding. Colors available, sizes, method of application all included in booklet.

66 METAL SPRAY—Metallizing Engineering Co, 21–07 41st Ave, Long Island City, N. Y. Metco News is devoted to latest developments and applications of metal spraying process.

67 BUILDING MAINTENANCE—Flexrock Co, 23rd & Manning Sts, Philadelphia, Pa. 68-page handbook shows how to do many odd jobs at lower cost with better results. Non-technically written, has over 150 pictures, diagrams and mechanical drawings.

68 OIL SEPARATOR—Gale Oil Separator Co, 405 Lexington Ave, New York, N. Y. 6-page bulletin covers "Profits from Waste Fluids" and tells about oil separator. Includes description of action, construction, and installation.

69 STEEL GRATING—Blaw-Knox Co, Pittsburgh, Pa. Catalog No. 1773 contains information on electroforged steel grating and stair treads. Section showing method of manufacture portrays micrographic analysis of forged structure of grating. Contains also tables of safe loads and size variation.

70 STEAM, AIR AND WATER EQUIPMENT—Johnson Corp, Three Rivers, Mich. 80-page catalog divided into five sections, describing Johnson products. Covers Johnson rotary pressure joint, "Pressure Equalizing" pump, Electrap, and others.

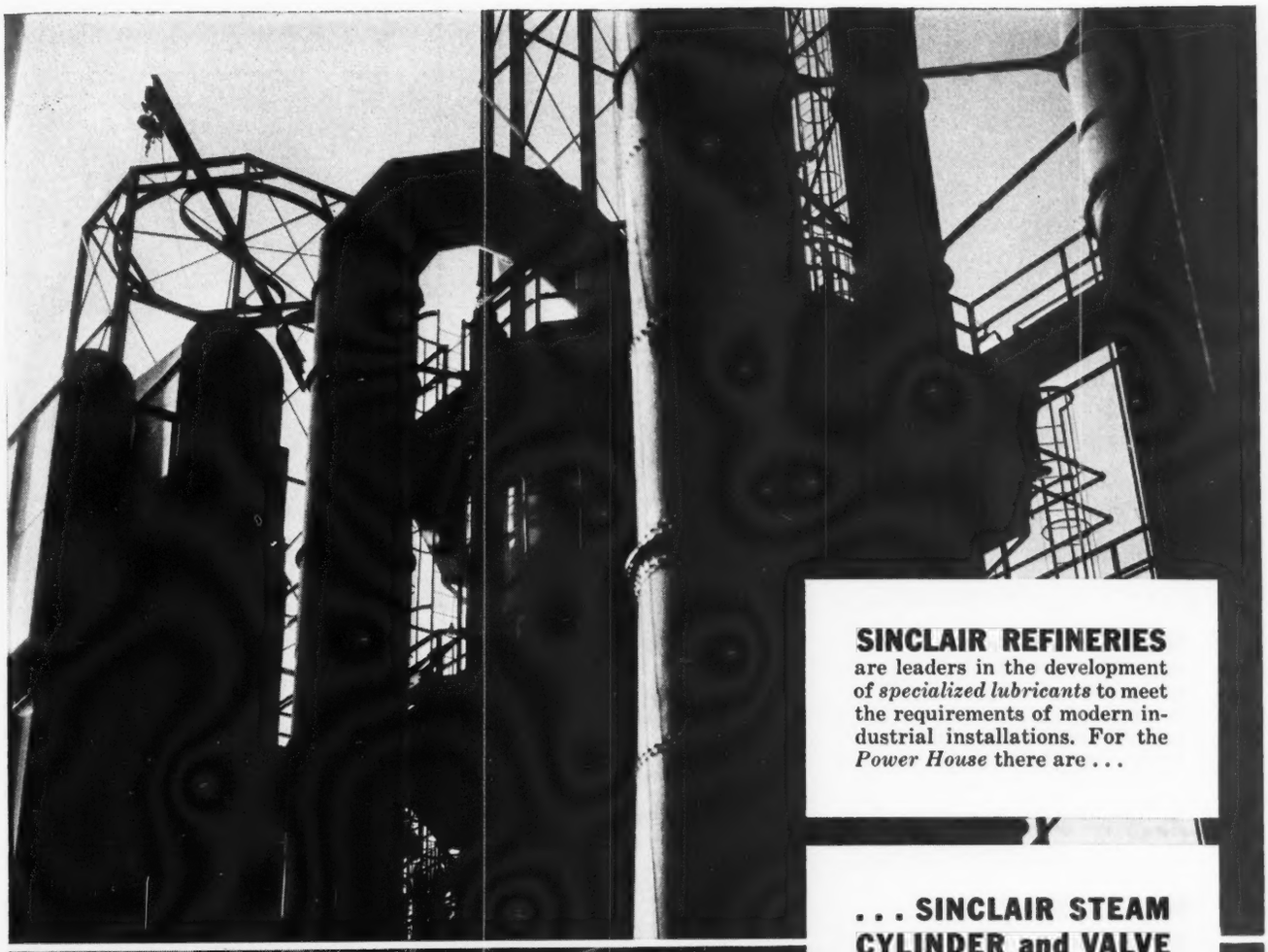
71 DEFENSE WORK—Hagan Corp, 300 Ross St, Pittsburgh, Pa. "Put Your Plant on a Preparedness Basis" booklet covers story of bottlenecks during last war, giving message to plant executives, and presents case stories of plants stopped by lack of new boilers, coal scarcity, and other contributing factors. Urges thorough checkup in plant to eliminate troubles in future emergencies.

72 PIPE TOOLS—Beaver Pipe Tools, Warren, Ohio. 8-page booklet describes models A, B, and C pipe tools, giving statements by users concerning usefulness. List of buyers included.

73 COOLING TOWER — Marley Co, Fairfax Rd & Marley Ave, Kansas City, Kansas. 4-page bulletin No. 202 gives design, construction, specifications and features of new size cooling tower, offered at special low price. Capacity in tons of refrigeration presented.

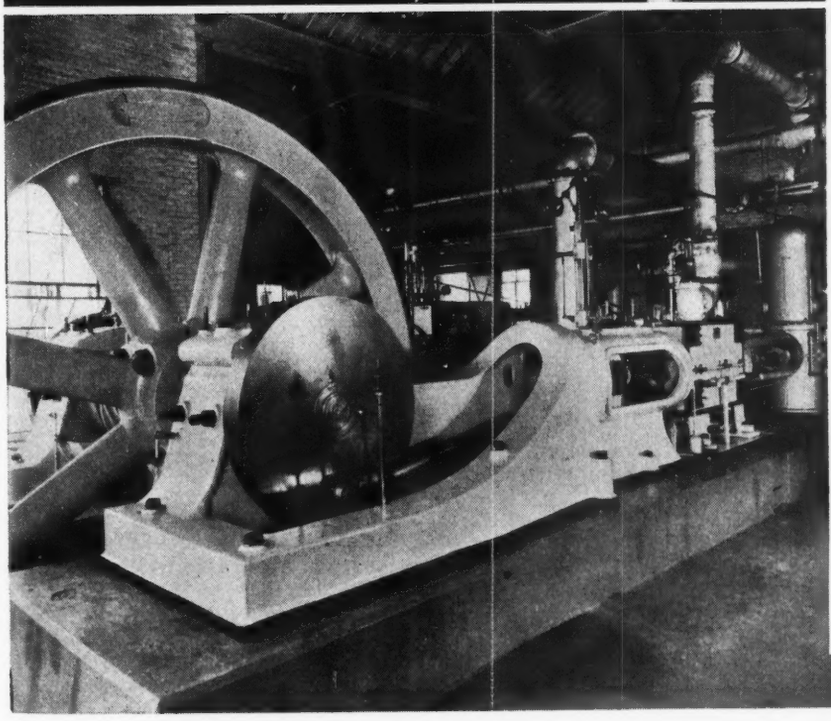
74 CLAMSHELL BUCKETS — Blaw-Knox Co, Pittsburgh, Pa. Catalog 1757 is devoted to two-line lever arm buckets and lists 242 buckets according to rated capacity. Records service classification of each bucket, and lists dimensions and physical data.

75 WELDING DIRECTORY—Lincoln Electric Co, 12818 Coit Rd, Cleveland, Ohio. 56-page bulletin No. 402 gives reasons why users should use Lincoln products, and includes complete directory of these products, such as cable, electrodes, protective and other welding supplies, etc.



SINCLAIR REFINERIES are leaders in the development of *specialized lubricants* to meet the requirements of modern industrial installations. For the *Power House* there are . . .

. . . SINCLAIR STEAM CYLINDER and VALVE OILS suited to the particular pressure, temperature and moisture conditions individual to your engines. Economy of operation and maintenance depend upon the correct oil. Sinclair has it. Sinclair engineers will gladly confer with you about the use of correct power house oils for your plant. Write the nearest Sinclair office or Sinclair Refining Company, 630 Fifth Avenue, New York, N. Y.



(left) **EQUIPMENT IN CITY WATER WORKS, OWOSSO, MICHIGAN.** *Steam Cylinders of this engine have been lubricated for past 6 years with Sinclair Superheat Valve Oil.*

Write for "The Service Factor", a free publication devoted to solution of lubrication problems.

SINCLAIR INDUSTRIAL OILS

SINCLAIR REFINING COMPANY (Inc.)

2540 W. CERMAK RD. CHICAGO · 10 W. 51ST ST. NEW YORK · 1907 GRAND AVE. KANSAS CITY · 573 W. PEACHTREE ST. ATLANTA · FAIR BUILDING, FT. WORTH

CAN YOU DO THIS?

"The Entirely Different Boiler and Engine Treatment"

HOLD A WHOLE

Month's supply of unfailing boiler scale and corrosion removal and prevention in the Palm of your Hand?

That's how simple it is with

SAND-BANUM

Only ounces applied once each week insure equipment free from scale and corrosion. Write TODAY for details of our "Satisfaction or No Money" guarantee trial offer.

AMERICAN SAND-BANUM COMPANY, Inc.

9 Rockefeller Plaza — **New York City**

WESTERN SAND-BANUM CO.

Houston, Texas — *Agencies in Principal Cities* — Fresno, Calif.

ONLY AS GOOD as the JOB it Does!

That's Lubrication—

and you'll never know its real *value* 'till your machinery *proves* it! ★ Made-for-the-Purpose LUBRICANTS keynote a *sixty-six* year Quality demonstration of our Brands of . . .

LUBRICATION

TURBINE OILS — **COMPRESSOR OILS**

CYLINDER OILS — **DYNAMO OILS**

DIESEL ENGINE OILS — **MOTOR OILS**

GREASES . . . *for every requirement.*

BORNE SCRYMSER COMPANY

ESTABLISHED 1874

17 BATTERY PLACE · NEW YORK

Power Lines

(Continued from page 166)

from as high as 1925 F and water quenching from as high as 1650 F failed to produce excessive hardening.

The effect of preheating and stress relieving is readily noticeable on the elongation before failure in free bending. These variables, however, have little if any, noticeable effect on tensile test results.

Both hardness tests and microscopic examination from a multiple-pass weld on a $6\frac{5}{8}$ in. OD x 0.432 in. wall pipe which was neither preheated nor stress relieved indicate a structure with a similarity to the air cooled heat-treated specimens previously mentioned.

Proper joint designs for pressure piping require a root opening and ring design such that proper fusion is obtained in the root of the weld in addition to the fact that the included angle of the welding groove should be sufficient to avoid excessive undercutting and thus avoid the possibility of trapping slag along the side walls of the weld.

Deep-etch tests taken from various positions from operators' appearance welds as well as physical tests removed from heavy wall pipe in the preheated and stress-relieved condition indicate electric arc welding to be a superior method of jointing carbon-molybdenum piping for high-temperature, high-pressure service.

1,800,000 Hp Diesels Produced Last Year

Total horsepower of stationary diesel engines reported by manufacturers for 1939 amounted to 667,802 hp, according to preliminary figures compiled from returns of the Census of Manufacturers for 1939 and released October 4 by the Bureau of the Census.

Data on production of diesels by type follows:

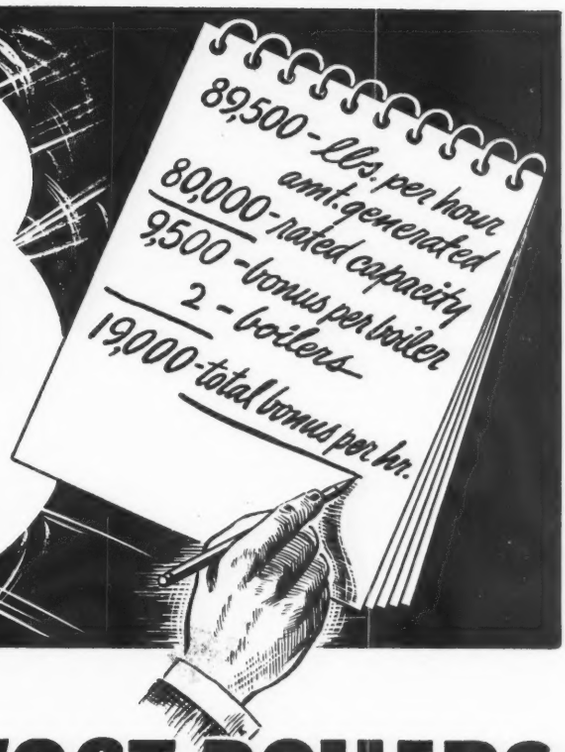
Type	Hp Capacity
Stationary	667,802
Marine:	334,513
For direct connection to shaft	115,051
For electric-drive and auxiliaries	63,126
For connection to propeller shaft through reduction gearing	156,336
Total marine	334,513
Portable and semi-portable	32,041
Other (inc. tractor, truck, railway diesel-electric)	775,414
Total hp	1,809,770

Cincinnati G&E Orders 65,000-kw Unit for Jan, 1942

Generating capacity of 65,000 kw will be added to its Columbia Park Station by the Cincinnati Gas & Electric Co with a General Electric turbine-generator just ordered and scheduled for shipment in January, 1942. The new unit will join three other turbine-generators already installed in this station, and will duplicate the most recently installed of these.

Of the tandem-compound type, it will be rated 81,250 kva, 1800 rpm, and 13,200 volts. Specifications call for hydrogen cooling and steam conditions of 650 lb and 900 F.

11½% STEAM BONUS



Two VOGT BOILERS

give 19,000 extra lbs. of steam per hour for Newport Industries, Pensacola, Fla.

Generating 89,500 pounds of steam per hour daily from units designed for 80,000 pounds, this large Southern Wood Naval Stores and Chemical Plant gets a *bonus* of 9,500 pounds of steam per hour from each of the two VOGT boilers, shown in the picture below. Wood and gas fuel is burned in combination, and the performance of these units is highly satisfactory to our customer.

Get more for your steam dollars, whether expended for plant or fuel, with plus-value VOGT steam generators. There is a type and size, for any pressure and any fuel, which will exactly meet your operating requirements with lowest operating and maintenance expense.

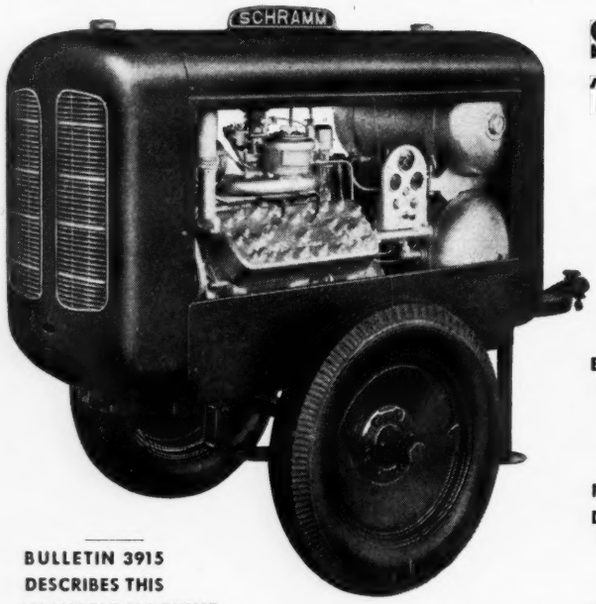
PRINCIPAL DATA, EACH UNIT

HEATING SURFACE:
Boiler, 12,200 square feet
Water Walls, 520 square feet
CAPACITY:
80,000 pounds steam per hour
OPERATING PRESSURE:
160 pounds per square inch
DESIGN PRESSURE:
450 pounds per square inch
FEED WATER TEMPERATURE:
230 degrees F.
FUEL:
Spent Wood, 7720 B. T. U. as fired (20% moisture)
Natural Gas, 1015 B. T U. per cubic foot

HENRY VOGT MACHINE CO.
INCORPORATED
LOUISVILLE, KENTUCKY
New York Philadelphia Cleveland
Cincinnati • St. Louis • Chicago • Dallas

Vogt WATER TUBE BOILERS
BENT TUBE, SECTIONAL HEADER & BOXHEADER TYPES

for Plant Maintenance



SCHRAMM "FORDAIR" 60

(60 cu. ft. air delivered per minute at 100 lbs. gauge)

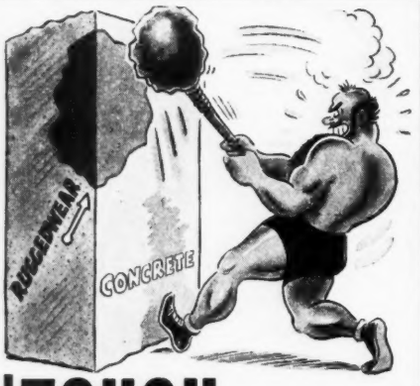
EASILY MOVED
GASOLINE ENGINE DRIVEN
ELECTRIC STARTING
FULLY AUTOMATIC
ECONOMICAL

WILL OPERATE
PAVING BREAKER
DRILLS FOR WOOD, METAL OR STONE
PAINT SPRAYS
RIVETTING OR CHIPPING HAMMER
SUMP PUMP
ETC., ETC.

BULLETIN 3915 DESCRIBES THIS VALUABLE MACHINE

OTHER SIZES 25 TO 420 c.f.m.
PORTABLE AND STATIONARY

SCHRAMM, INC.
ESTABLISHED 1900
WEST CHESTER, PA.



TOUGH REPAIR for BROKEN CONCRETE

Avoid accidents! Prevent costly delays! Repair holes, cracks, broken places in concrete floors or resurface an entire area with the durable RUGGEDWEAR RESURFACER. No chopping or chipping required. Merely sweep out spot to be repaired—mix the material—trowel it on. Holds solid and tight right up to irregular edge of old concrete. Cellulose-Processed to provide a firmer, tougher, smoother, more rugged wearing surface. Used indoors or out. Dries fast. Costs only 10c to 14c per sq. ft.

Valuable 68-page "HAND BOOK OF BUILDING MAINTENANCE" available to those requesting on business letterhead.

MAKE THIS TEST!

FLEXROCK COMPANY
2377 Manning St., Phila., Penna.
Please send me complete RUGGEDWEAR information . . . details of FREE TRIAL OFFER —no obligation.

Name .....
Company .....
Address .....
City ..... State .....

"STANDCO" PILLOW BLOCKS

Fig. 1635

Combining clamp block and pillow block requirements in one type, the "Standco" shown above is sturdily built and is offered in a wide range of sizes. Babbitted bearing surfaces are finished beautifully smooth, both faces machined. It can be depended on for long, trouble-free service.

Fig. 32

"Standco" Ball and Socket Pillow Block, Ring or Wick Oiling, Plain or Collar End Babbitted Bearings.

Write for Bulletin

STANDARD PRESSED STEEL CO.
JENKINTOWN, PENNA.

Boston Detroit Indianapolis — Box 577 — Chicago St. Louis San Francisco

Albert E Bonnet Dies

Albert E Bonnet, 66, chief inspector of the Hartford division of the Hartford Steam Boiler Inspection & Insurance Co, died at his home in Wethersfield, Conn., on Oct 6 after a short illness. He was a native of Brooklyn, N. Y., and was educated at Stevens Institute of Technology. After three years in stationary engineering practice he entered the merchant marine, serving for five years. He then joined the U. S. revenue cutter service as a lieutenant of engineering, operating in Alaskan waters, and in 1905 entered the insurance company's organization as an inspector at New Orleans, La. In 1913 he was transferred to the New York office, becoming assistant chief inspector. In 1923 he was promoted to his late Hartford post.

BUSINESS ITEMS

Lion Oil Co, El Dorado, Ark., has entered the eastern market by arranging to distribute its products through General Lubricants, Inc, 514 57th St, New York, N. Y., in New York, New Jersey and the New England States.

Elgin Softener Corp, Elgin, Ill., has opened an office at 215 N Mason St, Appleton, Wis. The office will be in charge of Ralph H Williams, who has been handling the Elgin line of water-conditioning equipment in Wisconsin.

Globe Steel Tubes Co has established a sales office in Philadelphia, at 1033 Broad St Station Bldg, in charge of Paul C Lewis, sales agent.

The Robins Conveying Belt Co, Passaic, N. J., has received, through Sargent & Lundy, consulting engineers of Chicago, a contract to design and furnish coal-handling equipment for the Commonwealth Edison Co's Chicago River plant. The equipment will include a gantry bridge for unloading and reloading coal barges plus a storage and reclaiming system.

Sterling Pump Corp, Hamilton, Ohio, has acquired the Turbine Pump Div of Roots-Connersville Blower Corp, Connersville, Ind. A transfer of inventory has already been made from Connersville to Hamilton, and all former Roots-Connersville installations will be serviced, if and when necessary, by an enlarged staff of Sterling engineers.

MEETINGS

American Institute of Chemical Engineers —*33rd Annual Meeting, December 2–4, St. Charles Hotel, New Orleans, La.*

American Society of Refrigerating Engineers—*36th Annual Meeting, December 4–6, Hotel Commodore, New York, N. Y. David L Fiske, secretary, 37 W 39th St, New York, N. Y.*

American Society of Mechanical Engineers —*Joint Meeting, ASME Fuels Div and AIME Coals Div, November 7–9, Hotel Tutwiler, Birmingham, Ala. 61st Annual Meeting, December 2–5, 1940, Hotel Astor, New York, N. Y. C. E. Davies, secretary, 29 W. 39 St., New York, N. Y.*

New York Power Show — *Grand Central Palace, New York, N. Y., December 2–7, 1940. Management, International Exposition Co., New York, N. Y.*

"CAN THAT OIL CAN, BUDDY!"

HERE AND THERE you may find a place where friction is so short-lived that it *doesn't* need a lubricant. But you don't find those places in your plants.

For in your machines *friction,* and the *heat* it generates are constant and severe; the damage they can do is great. You simply don't make the healthy profits you deserve from your Diesels or machine tools, your blooming mills or textile looms, unless you keep those two enemies thoroughly under control.

In this task, Shell lubricants as applied by the Shell men are daily doing a remarkable job. Plant after plant is finding that wear is retarded and less time is lost since they handed over their *heat* and *friction* problems to Shell.

• • •

It's not the easy jobs that attract the Shell men. The jobs they are proud of are the ones on which others have tried, and failed—though not from lack of effort. Won't you call in your Shell man today and ask for his recommendation on the meanest lubrication job in your plant? Then sit back and check your results.

SHELL

SHELL INDUSTRIAL LUBRICANTS

Another OAKITE IDEA to help you save!

LOW-COST WAY TO CLEAN PLANT FLOORS

Whether your floors are of wood, slate, concrete or terrazzo, you can keep them clean and slip-proof with half the effort and at an amazingly low cost the successful Oakite way!

Yes! With modern Oakite materials and methods to make your floor cleaning routine easier, every trace of grease, oil, trampled-in dirt is speedily removed. Floors are spic-and-span, quick-drying, safe to walk on. No dangerous, slippery film. Besides, cleaning is accomplished with complete safety both to floors and workmen.

Save Money ON ALL POWER PLANT MAINTENANCE JOBS

For safely de-scaling Diesel cooling systems, cleaning lube oil coolers, air filters, steam cleaning and other jobs, let Oakite materials save time and money for you. Ask for FREE descriptive booklets and specific, helpful data on your cleaning problems. No obligation.

OAKITE PRODUCTS, INC.
23 Thames Street, New York, N. Y.
Representatives in All Principal Cities of the United States and Canada.

OAKITE Certified cleaning
MATERIALS & METHODS FOR EVERY CLEANING REQUIREMENT

Bogue Electric Co, Paterson, N. J., has announced expansion of its line to include motor-generator sets to 200 kw, alternators to 200 kw, synchronous motors to 200 hp, dc motors to 400 hp, automatic battery-charging sets and generating units for diesel, steam, hydraulic and gas-engine drive complete with switchboard and accessories.

Iron Fireman Mfg will devote part of its plant capacity in Portland, Ore., to the manufacture of machined parts for Boeing 512 Flying-Fortress four-engined bombers. H T Banfield, president of Iron Fireman, emphasized that stoker-manufacturing activities are proceeding without interruption.

Orders received by the General Electric Co during the three months ended Sept 30 amounted to $185,156,837, 133% above the same period last year. This was the largest amount of new business ever received by the company in any 3 month's period.

PERSONALS

C N Rink has been appointed manager of the Air Conditioning Coil Div, McQuay, Inc, Minneapolis, Minn. For the past three years, Mr Rink has been manager of the Murray Co of Atlanta, Ga., one of the largest contractors and distributors of heating, ventilating and air-conditioning equipment in the industry.

P J Christy has been made manager of the Philadelphia office of Chicago Pneumatic Tool Co. He succeeds A M Brown, who has been transferred to Washington, D. C., as manager of the new branch opened there. The company also announced appointment of C A Diehl as manager of the Houston, Texas, office.

Walter H Proescholdt, a member of the engineering staff of Iowa Electric Light & Power Co for over 14 years, has joined Quaker Oats Co, Chicago, as assistant chief engineer. Mr Proescholdt is a graduate of Iowa State College at Ames and also completed a 2-year student engineering course at General Electric Co.

W Richison Schofield, formerly chief engineer of Leeds & Northrup Co, Philadelphia, Pa., has recently been appointed

W Richison Schofield

director of engineering. John W Harsch, assistant chief engineer, has been advanced to chief engineer, and Mr Harsch's former position has been filled by John F Quereau. Mr Schofield joined Leeds & North-

HERCULES
Seamless Copper
FLOATS

GUARANTEED TO STAND UP!

Every Hercules Float carries our guarantee to stand up under 350 lbs. working pressure and 500 degrees temperature.

Fabricated of seamless copper under our special spinning process. Hercules Floats are uniform in thickness and high in mechanical strength.

You can depend on Hercules for floats—in standard shapes up to 10 in. and in special types to your specifications—to give long, dependable, economical service.

Insure care-free maintenance of water level in your heaters, tanks, reservoirs and other equipment by specifying "HERCULES."

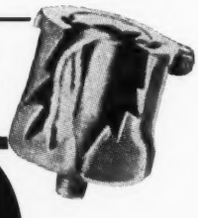
HERCULES FLOAT WORKS
200 Franklin St.
SPRINGFIELD, MASS.

HUNTER
'Airspring'
GREASE CUP

Drawn-steel, cadmium plated. Never known to rust!

'Shurflo' OIL CUP

Use where grit, dust or lint is a problem.



FREE SAMPLE

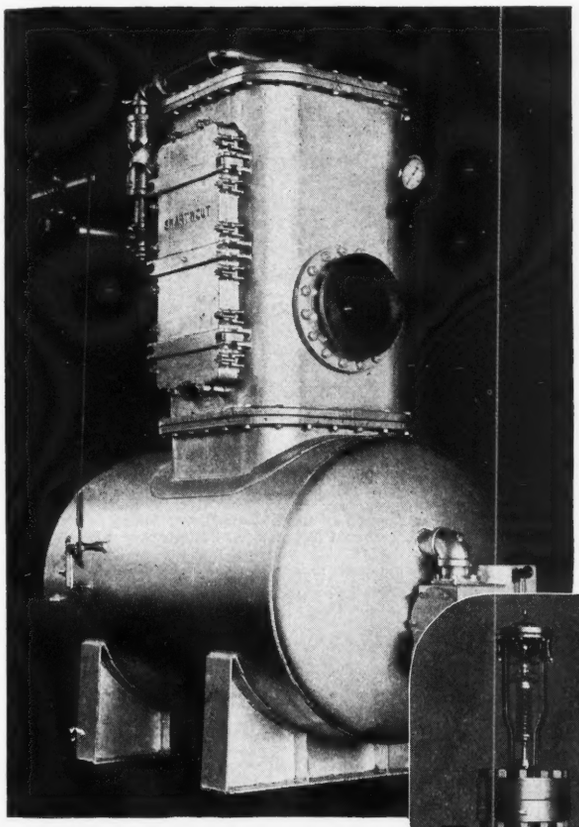
WRITE US ON YOUR LETTERHEAD

HUNTER SPRINGS - STAMPINGS

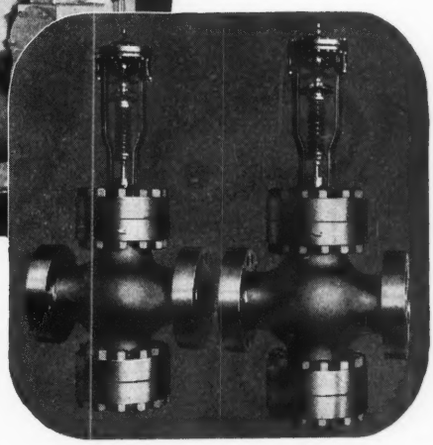
HUNTER PRESSED STEEL CO.
LANSDALE, PENNSYLVANIA

You're Dollars Ahead

with these three Swartwout Controls in your Power Plant



Swartwout Heater in Marshall Field & Company plant, Draper, North Carolina — another unit tailored to meet customer's requirements.



Swartwout Feed Water Regulators in use at Columbus & Southern Ohio Electric Company, Columbus, Ohio — 1350 pounds operating pressure.

Continuous, Adequate Feed Water Heating

Avoid the two most costly and troublesome threats to your efficient profitable operation of your power plant — uncertain control of boiler water supply and water levels. For the first, Swartwout Deaerating Feed Water Heaters assure you a constant supply of oxygen-free correct temperature water. Each heater is designed to meet your specific requirements. Rugged construction, highest grade accessories — *guaranteed trouble-free results at reasonable cost,* as hundreds of fortunate power engineers can tell you from actual experience. . . . Then —

Sensitive, Dependable Feed Water Regulation

It's assured by the Swartwout "S-C" Feed Water Regulator — a simple positive system, easy to install, at moderate expense. The famous "S-C" principle and Swartwout's careful manufacturing make for lower installation, operating, and maintenance costs.

Swartwout Feed Water Regulators take the worry out of water level control. . . . Lastly —

Swartwout Desuperheaters are made in both venturi and carburetor types, in 2" to 24" sizes.

More than 34 years active experience in this field equips Swartwout to maintain its excellent reputation with thousands of satisfied users of Swartwout power plant equipment.

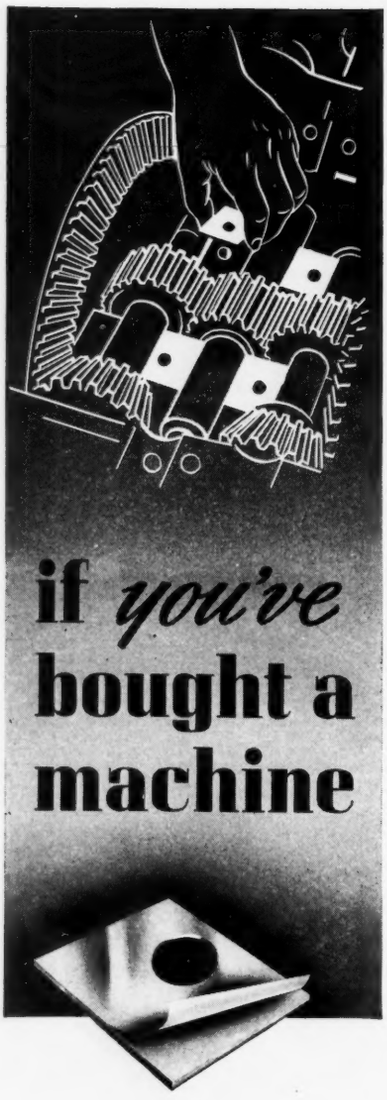
Positive, Controlled Desuperheating . . . Preparing steam for various processes or power production is achieved with safety and kept under rigid control by Swartwout Reducing and Desuperheating Stations. Complete equipment designed, built and serviced by Swartwout — a *unified* responsibility you can depend upon for performance that enhances your standing as a power plant engineer. • *You're dollars ahead with Swartwout Controls assuring greater safety and efficiency and lower costs. Write today for free bulletins and complete information.*

The Swartwout Company • 18501 Euclid Avenue • Cleveland, Ohio

Feed Water Regulators • Pump Governors • Feed Water Heaters
Master Controls • Reducing Valves • Separators • Exhaust Heads

Swartwout

•Power Plant Equipment•



if *you've* bought a machine

—or intend to...

Probably Laminum shims are standard equipment on your new purchase. If not, when you service it use Laminum for quick adjustments of bearings and fitted mechanical parts. It pays! Simply *peel* off .002 or .003 inch brass laminations. For *precision* adjustment! • *Shims cut to your specifications . . . stock shim materials are sold by mill supply distributors.*

Laminated Shim Co., Inc.
61 Union St., Glenbrook, Conn.

Write for file-folder of shim application photos—with Laminum sample.

LAMINUM
THE SOLID SHIM THAT *peels* FOR ADJUSTMENT
A-1170

rup in 1916 and has been chief engineer since 1928. An authority on pyrometry and automatic control, he holds important patents in these fields.

J S Diefenbach of Derby, Conn., has joined the sales force of L Heres de Wyk & Co, engineers and manufacturers agents with offices in Ansonia, Conn., and Boston, Mass. Mr Diefenbach is a mechanical engineer graduated in 1932 from Rensselaer Polytechnic Institute.

A D MacLean, former chief engineer of Pittsburgh Equitable Meter Co, has been named vice-president of the company. Mr MacLean, a graduate of Harvard University's School of Engineering, has been with Ashton Valve Co, and with New Departure Div of General Motors Corp.

Lloyd B Edwards and associates have been appointed district representatives of Universal Gear Corp for the Minneapolis territory. Offices are at 841 Lumber Exchange Bldg, Minneapolis, Minn.

Neil H Brown, 1117 Liberty Life Bldg, Charlotte, N. C., has been appointed district representative for Northern Equipment Co, Erie, Pa., for Copes feedwater regulators, differential valves, pump governors, etc.

Roger H Clapp, formerly Philadelphia branch manager, has been made assistant general manager of sales for John A Roebling's Sons Co, Trenton, N. J.

OBITUARIES

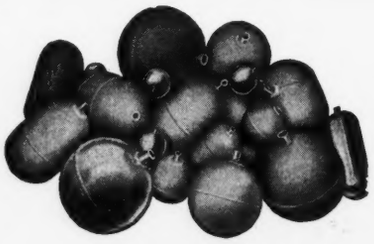
John V MacDonald, 65, chief engineer of the Athol (Mass.) Gas & Electric Co, and for 46 years a member of its staff, died October 7 at a hospital in Chatham, N. B., while on a visit to his boyhood home.

Max Rotter, 73, vice-president in charge of engineering for the Busch-Sulzer Bros-Diesel Engine Co, and said to be the man who designed the first diesel engines for submarines of the U. S. Navy, died October 6. Mr Rotter had been associated with Busch-Sulzer since the start of the plant in St. Louis in 1911. He came there from the Allis-Chalmers Co, for which he was chief engineer.

Arthur P Homer, 64, former president of the Power Transmission Council when its headquarters were in Boston, died at his home in West Townsend, Mass., October 10. He was a native of Galveston, Texas, and at the age of 21 left the University of Texas to become a coal passer for the Galveston Rope Co, becoming superintendent two years later. Mr Homer's subsequent career embraced steel making, shipbuilding and service as a consultant and special envoy for the U. S. Navy during the first World War. As head of the Power Transmission Council he was identified with nation-wide activities in connection with the application of group drives to machinery under engineering control. He retired from that post a few years ago.

Charles Andrew McCune, 61, research engineer and secretary of the Magnaflux Corp, New York, died October 14 at Atlantic City, N. J. Mr McCune, a former president of the American Welding Society and of the International Acetylene Association, had been in Atlantic City for several days on a vacation. His home was in Larchmont, N. Y. A native of Jersey City, N. J., Mr McCune attended Cooper Union

NICHOLSON



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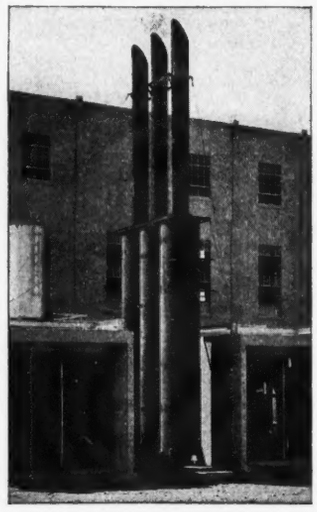

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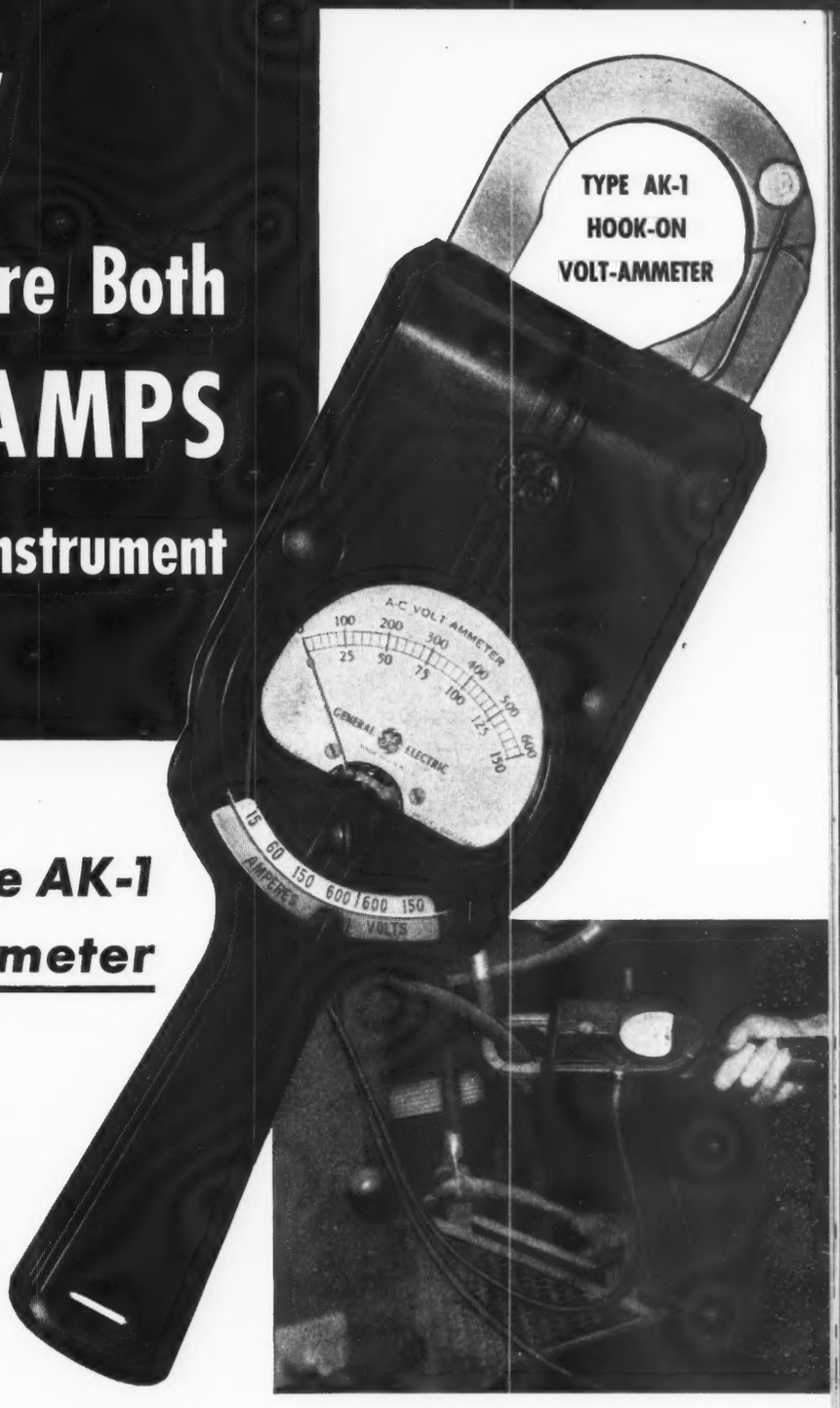


That's Why We Call the AK-1 A Hook-on Volt-ammeter

IT'S no trick at all to measure both alternating current and voltage with it. All you do is hook the instrument around the line and read amperes. Then connect the leads to the binding posts and read volts.

No Additional Equipment Needed

You don't need a separate transformer, voltmeter, or any other additional equipment. And you don't need to cut conductors or shut down equipment to make your measurements.

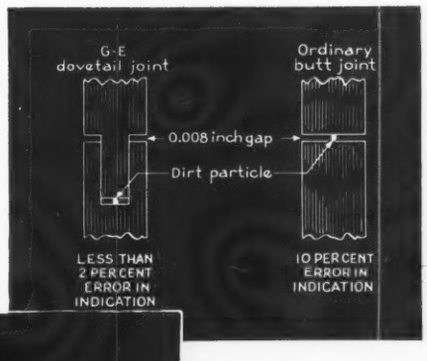
One Setup to Measure Current and Voltage

After measuring voltage, leaving the leads connected does not affect hook-on current readings. Just flick the selector switch to either "Amperes" or "Volts" according to the measurement you want.

Our bulletin GEA-2950 describes the AK-1 in detail, and illustrates how easy it is to use. Order a copy from your nearest G-E Office, or write General Electric, Schenectady, N. Y.

For Emergency and Maintenance Testing

This instrument is particularly handy for quick, accurate measurements when you have trouble with electric equipment and need the answer to circuit conditions in a hurry. Also, you will find it very useful for checking the loading of motors, and for other routine maintenance measurements.



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For Your Engineering File

Power offers nine reprints of its Special Sections, designed for quick reading by the busy power engineer. Illustrated with diagrams, charts and tables.

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in New York and in 1900 became chief draftsman of the Safety Car Heating and Lighting Co. Then, successively, he was assistant engineer and chief engineer of the Commercial Acetylene Co, sales engineer of the Page Steel & Wire Co, director of research of the American Chain Co and director of research of the Welding & Research Corp. Since 1932 he had been associated with the Magnaflux Corp, which licenses the use of a special non-destructive method of testing metals for faults, one which Mr McCune helped to develop.

Current Comment

A Power Engineer's Duties—1890 and 1940

THE POWER ENGINEER of 1890 was by far a a better mechanic in his time than present engineers. The reason is because he had far less plant equipment and his principal duties were lacing belts, aligning drive shafts, babbiting bearings and making all types of boiler repairs from washing to changing tubes. In 1940 we find the old-time engineer far outmoded, we have 1500-lb steam plants, 500- to 1500-ton refrigeration plants for air conditioning, 5- to 12-in. vacuum heating systems, high-speed turbines, and artificial swimming pools which require constant service for filtration and water treatment.

Very often we hear it said the modern engineer is not as efficient as the old timer. Why are such remarks made? The reason is that no present power engineer *can* be as efficient with all of our modern power-plant equipment and small amount of engineering training available to the average man not financially able to take a 4-year course at some engineering college.

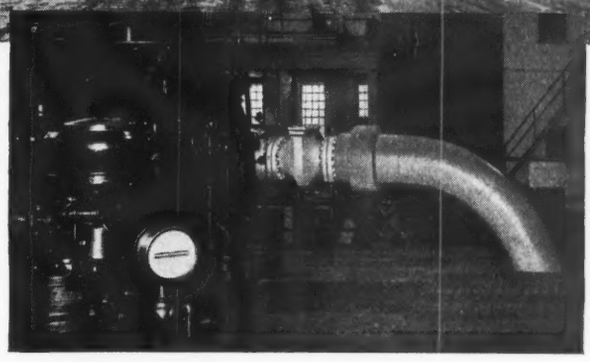
In 1940 we find our modern engineering profession with a very limited number of modern power engineers. Those who are available received their education in the "College of Hard Knocks" and through many hours of part time training in home study night schools.

Let's consider briefly some of the problems confronted by the power engineer of today: He is called upon to give reason for a filtration plant not removing proper amount of impurities from the water used for drinking or artificial pools or the reason for not supplying the entire building with sufficient hot water at remote risers. He is asked why coal consumption is too high, steam too wet for processing purposes, main-drive-motor bearings overheating, flickering electric light system, air-conditioning system not removing sufficient moisture from the conditioned air. Most complicated of his duties is starting a new plant. To date the writer has not seen one such plant wherein the new equipment was more than 75% complete and ready for efficient operation. The reason is the very limited experience of the designing and constructing engineers.

Now let us consider one of the many problems in engineering, that of a cooled drinking-water system in a large hotel. After five years of operation, the water in one system I know of gave off an objectionable odor. As time progressed the

THIS K & M INSULATION AS EFFICIENT AS EVER AFTER 17 YEARS' MAINTENANCE-FREE SERVICE OUTDOORS

Above—View at the Natrona, Pa., plant of Pennsylvania Salt Manufacturing Co. showing part of the 24" steam line that was insulated in 1923 with K & M "Featherweight" 85% Magnesia. At right is shown the connection of the steam line at the turbine.



The 24-inch steam line shown in the illustration runs from turbine to evaporator at the Natrona, Pa., plant of the Pennsylvania Salt Manufacturing Company. Its total length is 430 feet, of which 220 feet are outdoors. Its insulation of Keasbey & Mattison "Featherweight" 85% Magnesia was applied in 1923.

This insulation has spent the last 17 years conserving heat as efficiently as the day it was installed. It has been subjected to sizzling sun and freezing cold, to rain and snow and all the other weather 17 years will bring. Yet not a cent has been spent for maintenance, and it is ready to fight the elements for more decades to come.

K & M "Featherweight" 85% Magnesia, famous as one of the most efficient heat insulators ever developed for temperatures up to 600° F., is but one of a complete line of Keasbey & Mattison products, specialized for every insulation purpose. They are saving heat, fuel and dollars in plants the nation over.

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WATCH FOR POWER'S COMPLETE DIRECTORY OF POWER EQUIPMENT AND SUPPLIES — COMING IN MID-DECEMBER ISSUE

odor became more intense and after one and a half years' of attempting to rectify the condition, such as cleaning filters, etc, the water was sent to a chemist. He found no impurities; just an odor. The system was then flushed out and refilled, which corrected the condition for about six months; then the odor returned.

Finnally the power engineer studied the design of the complete system and found that no provision had been made to prevent the system from becoming stagnant other than continuous circulation and cooling. Thus when demand on the system became low the fresh water makeup also became low with the result that the water became stagnant. This was rectified by causing the system to have a continuous overflow into the general water system and admitting air at the suction side of the circulating pump. This is only one of many problems and its remedy.

Some of the other problems are having the complete refrigeration system (ammonia) diluted with water slowly over a period of several weeks because of a leak in the direct-expansion system of the water cooler; breaking of tubes in air-conditioning fin-type coolers caused by closing valves on both sides of brine lines to cooler; having the tubes bow in a water-tube boiler on low pressure caused by slow circulation at low steam pressure. This latter was rectified by increasing the number of circulating tubes to drum by 50%.

Many matters of electricity are today the problems of the power engineer, and he is often called upon to determine the cost of generating power with steam or diesel as compared to utility service. Elevator equipment has been greatly advanced due to higher speed demands and automatic levelling—there again the power engineer is called upon to supervise the maintenance that prevents interruptions of service.

All these are only a few of the problems that have complicated the power engineer's task. Thus, compared by the standards of 50 years ago, the engineer may appear to know less and less about more and more. Actually, however, he has far more responsibility, his job embraces more territory, and in general, his performance standards are much higher today than in 1890.

Buffalo, N. Y. LEONARD W THIELE

Arc Welding Has Too Many Doctors

Arc welding has too many doctors. An operation which is perfectly natural, very simple and very easily accomplished, has largely been changed in the minds of the public to an art which takes on the mystery of voodooism with an admixture of the art of the medicine man.

The public is beginning to think that the welding operator is a cross between a miracle man and a professional musician. This opinion is groundless. The only thing that a welding operator can do is to hold the end of an electrode at a certain distance above the deposited metal and advance it along the seam to be welded at a certain speed. There is nothing more that is involved in this operation. It is neither complicated nor difficult. As a

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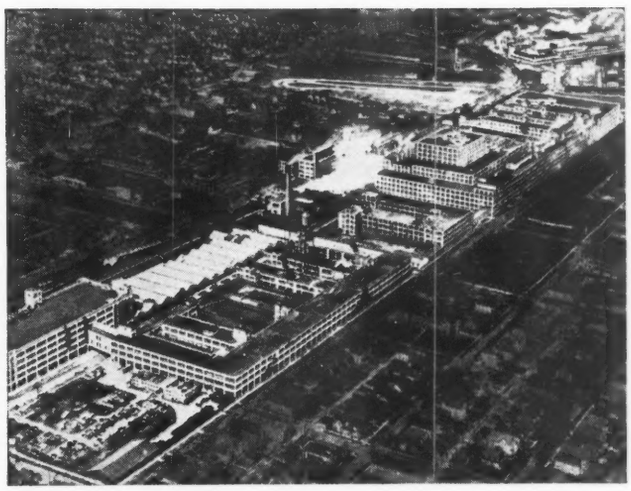
The Detroit factory of the Packard Motor Car Company (right) burns over 80,000 tons of coal a year . . . bituminous coal from mines in Kentucky, Virginia, and West Virginia.

Have *you* a power or heating problem in your plant? Probably the economy answer is *modern* equipment burning a *modern* fuel, *Coal*. Chesapeake and Ohio's combustion experts will gladly help you make comparative cost and efficiency studies—no charge of course.

Our Fuel Service Engineers can also help you secure the type of coal best suited to your needs



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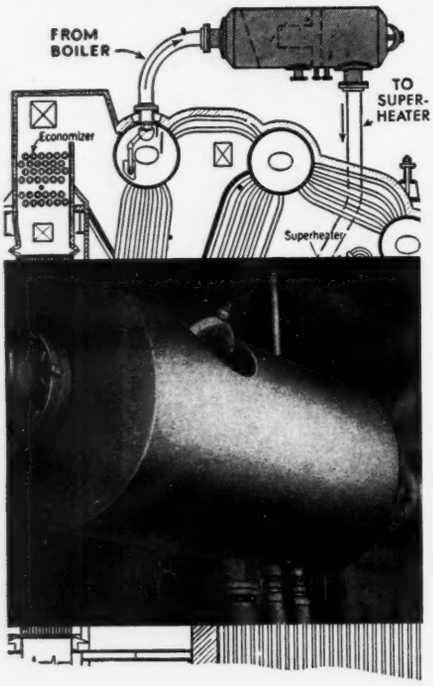

Here's one plant . . . that increased capacity 270% of boiler rating . . .

In a large process plant an average of 194% of boiler rating was required but 150% could not be exceeded without excessive carry-over. Cochrane Purifiers were installed and the desired conditions readily attained—a 96-hour test gave perfect results at 270% of boiler rating.

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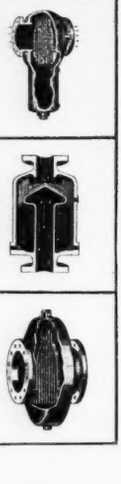

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matter of fact, with proper electrode, proper setting of the welding machine and proper preparation of the work, it is practically impossible to make a weld which will not stand up in service without having it so evident to the inspector that he would immediately reject it. It is possible to have defects in the steel that cannot be seen which will make a steel structure dangerous. It is impossible, however, to make a weld on that structure which is dangerous without it being obvious to anyone looking at the weld.

The reason we hear so much about the necessity of skill and care in welding is largely due to the fact that the operation itself is so simple that it is difficult to find much about it to discuss in papers, lectures and statements. Therefore, many of these eccentricities which are volubly discussed in magazine articles, lectures and statements, consist of theoretical possibilities which exist only in the minds of the lecturers and seldom exist in reality.

It is time that we got away from trying to make this very simple operation mysterious. It is time that we recognize the fact that the metal deposited by the shielded arc electrode is definitely better than the parent metal it is joining. It is time we recognize that there has never been a failure on an insured pressure vessel made by the shielded arc process. It is time we recognize that in the usual design if only half a weld is made it will withstand all of the normal requirements of the structure. It is time we recognize that failure in welds which are made by the methods recommended by any reliable manufacturer never exist. It is time we recognize that there is no mystery in welding and that making a welded joint is far more simple than making a riveted joint and more simple than making the steel which is joined together by this process. It is time we recognize that to spend time, money and attention in removing the least possible flaw from the deposited metal is silly in the light of the obvious flaws which must occur in the parent metal. A factor of safety is used to guard against these flaws. That is more than is needed in any commercial weld.

When we do recognize these facts we will have done two things: First, we will have given the green light to one of the most economical processes now known for the production of many structures. Secondly, we will have removed one of the fears which the uninitiated have developed regarding a perfectly normal manufacturing operation.

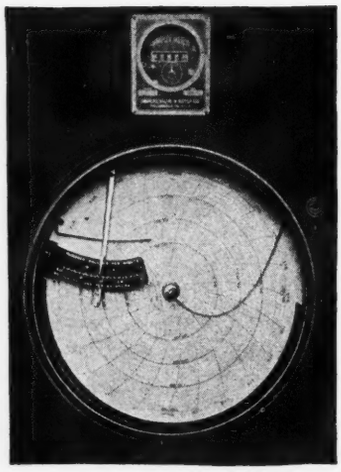
Cleveland, Ohio J F Lincoln
President, Lincoln Electric Co

Recent Bulletin Received

Development of Superduty Refractories from Ohio, Pennsylvania and Kentucky Fire Clays. *Published by Engineering Experiment Station, Ohio State University. 80 pages, paper bound, price $.60. Written by Ralston Russell, Jr.*—Gives all material relevant to development of such clays in past few years, with graphs and charts showing characteristics of some of the clays.

SIMPLEX METERS

THE UTMOST IN ACCURACY



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Simplex flowmeters combine in their design these functions. Let Simplex instruments aid you in solving your flow measuring and control problems.

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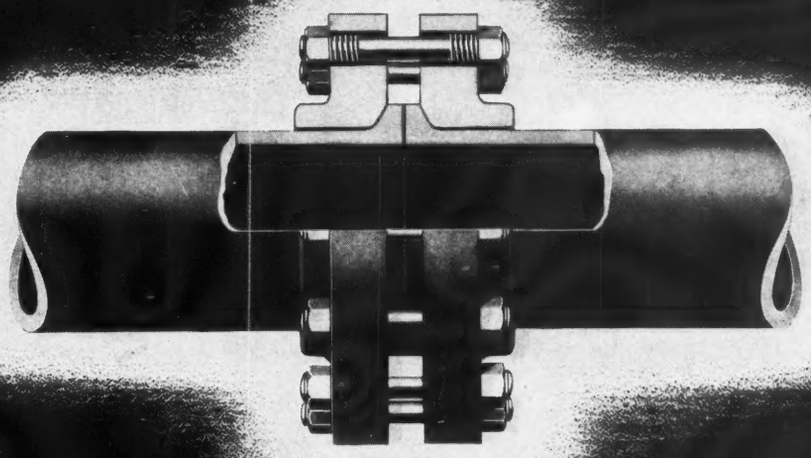

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Called "Globack" because the back face of the lap is a segment of a globe or sphere, this high pressure pipe joint is a big improvement upon regular lapped (Van Stone) joints. Developed by Midwest, "Globack" Joints have these important advantages: (1) in critical area of lap, the metal thickness is much greater than pipe wall thickness, consequently the lap is stronger in shear; (2) distribution of bolting pressure is uniform, and fair seating of flanges is assured; (3) bending moment to which the lap is subjected is less because the maximum stress is removed from lap periphery and the resultant bolting force is shifted toward the pipe wall.

The Midwest "Globack" principle is also applied to other flanged joint facings: tongue-groove, male-female, etc. Let us tell you about some of the recent outstanding high pressure, high temperature central station piping installations that have Midwest "Globack" Joints.

MIDWEST "GLOBACK" (VAN STONE) LAP

Dotted line indicates full pipe wall thickness (Van Stone) lap, and shows that Midwest "Globack" Joint provides maximum strength in critical lap section—where strength is most needed.

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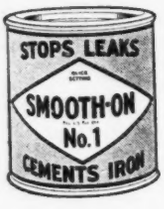

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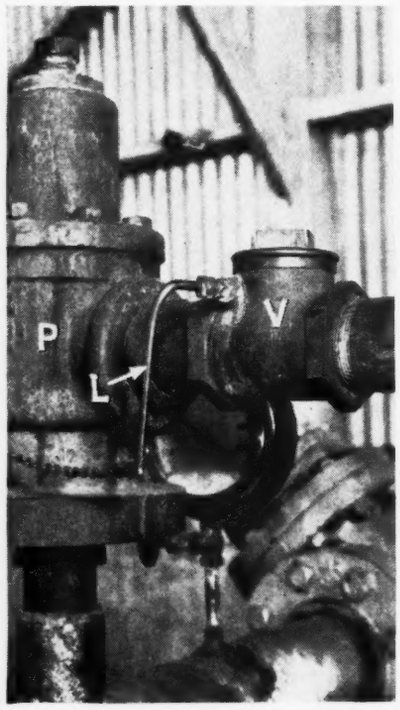
Operating Shorts

Pressure Regulator Stops Pump Automatically

A GROUP OF TANKS scattered over several miles of rough country were filled with water by a gasoline-engine-driven pump. When the last tank became full, a float-operated valve closed and pressure built up in the line. This stalled the engine and killed it. In addition to being unreliable, this method resulted in pipeline leaks caused by excessive pressure.

The photo shows a method of stopping the engine, developed by one of the mechanics, which has proved highly satisfactory. He welded a 2-in. coupling around a hole cut in the water line near the pump and connected a pressure regulator *P* to it. A check valve *V* was installed in the discharge from the regulator. He removed the stem of the check valve and welded a small packing gland around the hole in the valve body and made a combination pin and lever *L* from a piece of brass rod. On one end of the rod he mounted the disk of the valve and to the other connected, by a light chain, the trip pin of a switch, which, when released, short-circuited the engine magneto.



The regulator was adjusted to lift at a pressure slightly higher than that required to fill the most distant tank. Now, when the last valve at the tanks

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The central, or power, rotor and the two idler rotors are so designed that no pilot or timing gears are necessary, and the one stuffing box is that for the power rotor spindle, which is under suction pressure only. There no valves.

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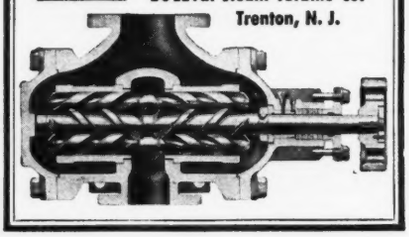

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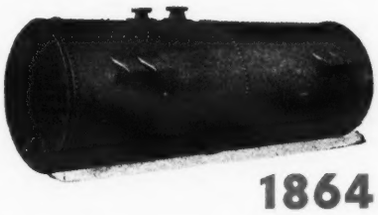
with Chain Guide

MAKE YOUR OVERHEAD VALVES SAFE and EASY TO REACH—
CONTROL VALVES FROM THE FLOOR

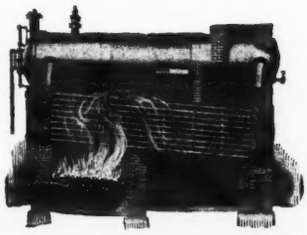
With Babbitt Sprocket Rims on your overhead valves, you can control valves instantly from the floor. Far quicker and safer than climbing ladders.

Babbitt Rims are easily attached in a few minutes, are inexpensive and assure safe, positive and instantaneous overhead valve operation. Available for valves of every make or style. Write for details.

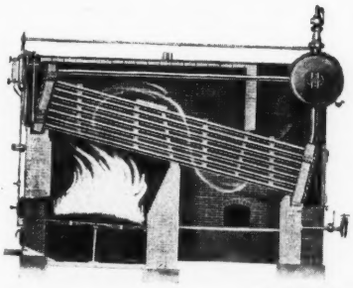
BABBITT STEAM SPECIALTY CO.
New Bedford Mass.



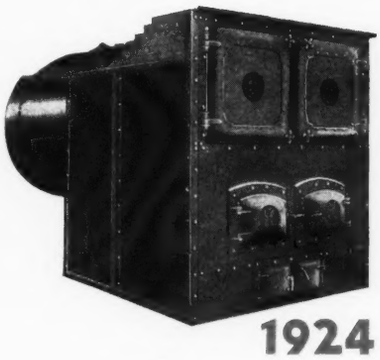
1864



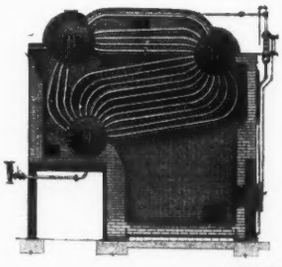
1901



1908



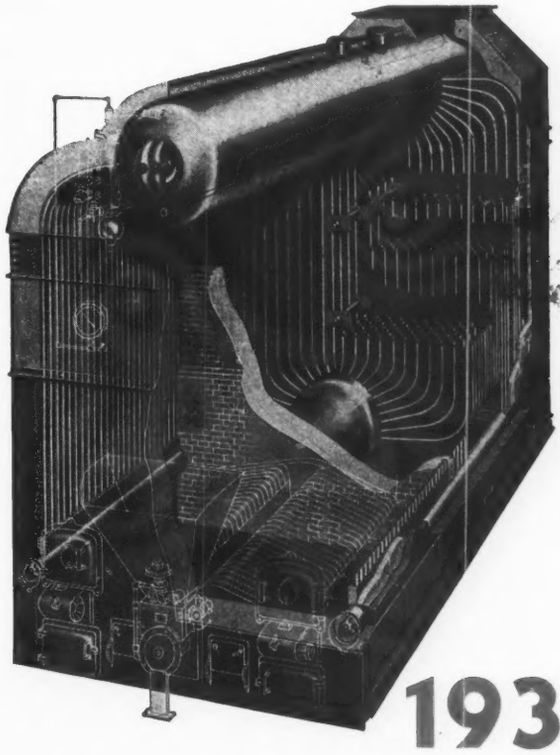
1924



1930

"TIME MARCHES ON"

The illustrations on this page show developments in the design of steam boilers since Civil War days. In the same year (1935) that Chicago was celebrating a "Century of Progress", the E. Keeler Co. announced the Keeler C. P. Steam Generator, illustrated below. With its insulated steel cased water walled setting, outperforming all previous designs and remarkable for its low cost of maintenance, this unique boiler is the last word in boiler design.



1935

One user writes: "I didn't realize how antiquated my old boilers were until I installed a Keeler C. P. Steam Generator." After two years use another customer writes: "Since this boiler has already paid for itself, we feel that our judgment in selecting this equipment has been thoroughly vindicated."

Over four hundred units are now in use or on order.

E. KEELER CO.

WILLIAMSPORT, PA.

Please send copy of Bulletin F-9

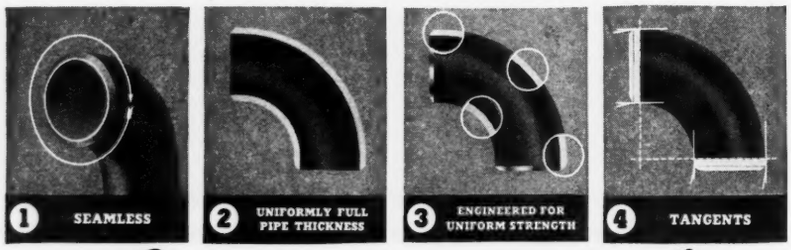
Name .....

Title .....

Firm .....

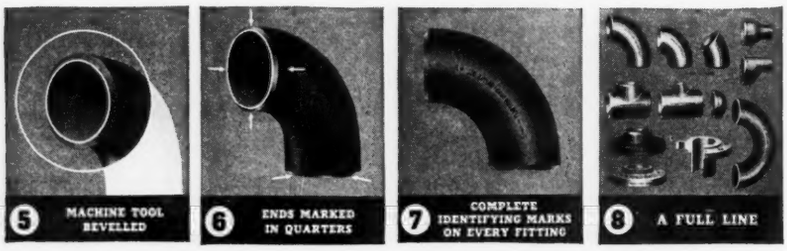
Address .....

TAYLOR FORGE



On your next job

make the acquaintance of the only welding fittings that offer you all these 8 aids to faster, easier welding



WeldELLS

Seamless Pipe Fittings for Welding

TAYLOR FORGE & PIPE WORKS

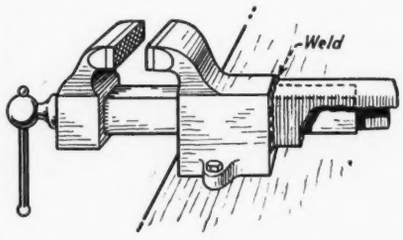
General Offices and Works: Chicago. P. O. Box 485
New York Office: 50 Church St.
Philadelphia Office: Broad Street Station Bldg.

is closed by float action, pressure increases slightly and the regulator opens. Water then rushes through the check valve and lifts its disk, which in turn trips the short-circuiting switch on the magneto and shuts down the engine. Water discharged from the regulator is piped into the suction of the pump.

Alhambra, Calif. G M WILSON

Shield Prevents Vise Damage

ALTHOUGH MODERN SHOP VISES are designed and built to withstand a great deal of rough usage, their use as anvils, where they are called upon to stand the strains of heavy hammer blows, should be strongly condemned. While much can be done to prevent damage to vises by properly instructing persons who use them, the vagaries of



the human being must always be considered, and further precautions are advisable.

In one large plant possible damage to vise beams is guarded against by shielding the protruding extensions with heavy hood-shaped sheet-steel guards. These guards are welded onto the back of the stationary jaws of revolving vises as in the figure. When the vise is fixed, they are bolted to the work-bench top.

Congas, Ala. S H COLEMAN

Smooth Bends in Angle Irons

WE EXPERIENCED CONSIDERABLE TROUBLE in making satisfactory bends, on a 3-ft radius, in sections of angle iron. Even though a bending machine was used, the finished angle bends had considerable twist when they left the bender, requiring expensive straightening.

After several trials we hit upon the idea of bolting two angles together to form a T-bar. The bolt holes were located 10-in. apart so that they could also be used to fasten the bent angles into place where they were being used. This method produced finished bends without twist.

Leeds, England W M HALLIDAY

96 PAGES OF VALUABLE DATA ON RESISTANCE PROBLEMS

HERE'S a book that really works for you. The new Ohmite Catalog and Engineering Manual No. 40 is different—it's a complete handy reference on resistance application problems. It contains useful reference tables, complete dimensional drawings, practical engineering data and a manual of resistance measurements. It describes the most complete line of stock units and special units for Power, Industrial, R.F., and Precision applications. It gives a complete listing of Generator Field Control Rheostats. It tells you how to select the right units for any of your needs. Mechanical and Electrical Engineers, Superintendents, Laboratory Men, and Purchasing Departments will find it an invaluable guide on the use of Resistors, Rheostats, Tap Switches, Chokes, and Attenuators in Generating Equipment—in Voltage Regulators, Switchboards, Rectifiers, and Meter Multipliers. You'll want it handy for ready reference on the control of motor speed, of generator fields, of heat and light, of signal and supervisory circuits—in power, electronic and radio equipment—in products and machine tools—in maintenance, laboratories and production. You can have it without charge. Just clip this coupon to your letterhead or write us on company stationery.

OHMITE MANUFACTURING COMPANY
4824 Flournoy St., Chicago, U.S.A.

Please Send Catalog 40.

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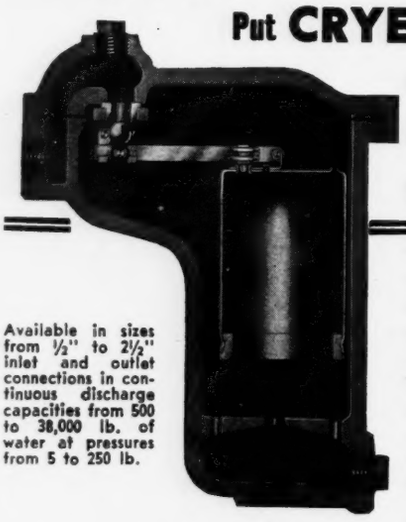
Be Right with OHMITE
RHEOSTATS ★ RESISTORS ★ TAP SWITCHES

ELIMINATE YOUR TRAP TROUBLES

Put CRYER STEAM TRAPS on your lines . . . they're GUARANTEED to solve your problems.



Available in sizes from ½" to 2½" inlet and outlet connections in continuous discharge capacities from 500 to 38,000 lb. of water at pressures from 5 to 250 lb.

If you're troubled with air binding, dribbling, slow venting, unreliable drainage or too frequent maintenance of your steam traps — let CRYER show you how you can eliminate these headaches, save steam and step up steam line efficiency.

CRYER INVERTED BUCKET STEAM TRAPS are proving the solution to trap trouble problems in scores of plants because they are designed to operate properly under all conditions, insure mechanically controlled quick venting, are positive in action at all times and provide sufficient capacity to prevent sudden surges from interfering with normal operation.

Ask for Details on fast, positive-action, trouble-eliminating, accessible CRYER STEAM TRAPS. Find out why they quickly pay for themselves.

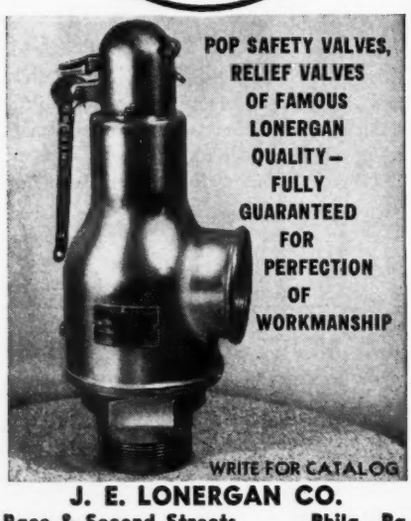
CRYER TRAP & VALVE CO., INC.

Manufacturers of Steam Specialties for more than 40 years.

366 Madison Ave., New York, N.Y.

Lonergan

GAUGES *Valves* *specialties*



POP SAFETY VALVES, RELIEF VALVES OF FAMOUS LONERGAN QUALITY— FULLY GUARANTEED FOR PERFECTION OF WORKMANSHIP

WRITE FOR CATALOG

J. E. LONERGAN CO.

Race & Second Streets Phila., Pa.

300 Specialties for Power Plants • Since 1872

The time to Stop Trouble is before it starts - - - -

It's always hazardous for nuts to work loose. The effect may mean injury to some workman or damage to your equipment. Play safe. Use

UNSHAKO

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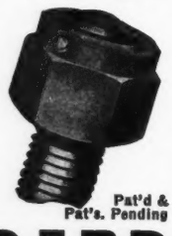
The Nuts that can't shake loose

on foundations and all moving parts of Diesels, Reciprocating Engines, Pumps, Conveyors, Generators, Stokers, etc. They "spring to life" and grip the bolt or stud whenever there's a backing-off tendency and thereby insure permanent tightness. Of course, they can be removed with a wrench and used over again if desired. Write for complete details.



Pat'd & Pat's. Pending

STANDARD PRESSED STEEL CO.

JENKINTOWN, PENNA.

Boston Detroit Indianapolis Box 577 Chicago St. Louis San Francisco

Experience With Cracks in Boiler Plates

A G WIGGINS, on page 100, August POWER, discusses the causes of cracks in boiler plates. I have had considerable experience with this trouble that may be of interest. Some years ago 10 large Lancashire boilers were set so that combustion gases in the side flues would contact parts of the shell over the steam space, to superheat the steam.

Recently an insurance company objected to setting other boilers this way, because cracks might develop in the exposed plates. To check this theory the 15-year-old boilers were opened and carefully inspected. Hundreds of hair cracks 2 to 3 in. long and about ⅛ in. deep, running lengthwise of the boiler, were found in the steam-space plates of some of the boilers; others were free of cracks. In the same boiler some plates cracked and others in a similar location did not. We came to the conclusion that the difference in plate performance was due to a difference in the quality of the steel in the plates.

On a large firetube boiler with 3.75-in. tubes we had a lot of trouble with leaky tubes in the front plate. This trouble was caused by cracking of the bridges between tube holes. We tried several methods of correcting this trouble, even to welding the cracks in the plate and the tubes to the plate without complete success. Part of the welding was done electrically and part with gas with about equal results. We found this trouble in other boilers of this type, which were operating at 200 lb pressure.

Scotch marine boilers are addicted to cracking. This trouble has been greatly reduced by fitting the furnace doors with a gadget to close the stack damper when the doors are opened and open the damper when they are closed. Preventing cold air from passing through the boilers worked wonders in preventing cracks.

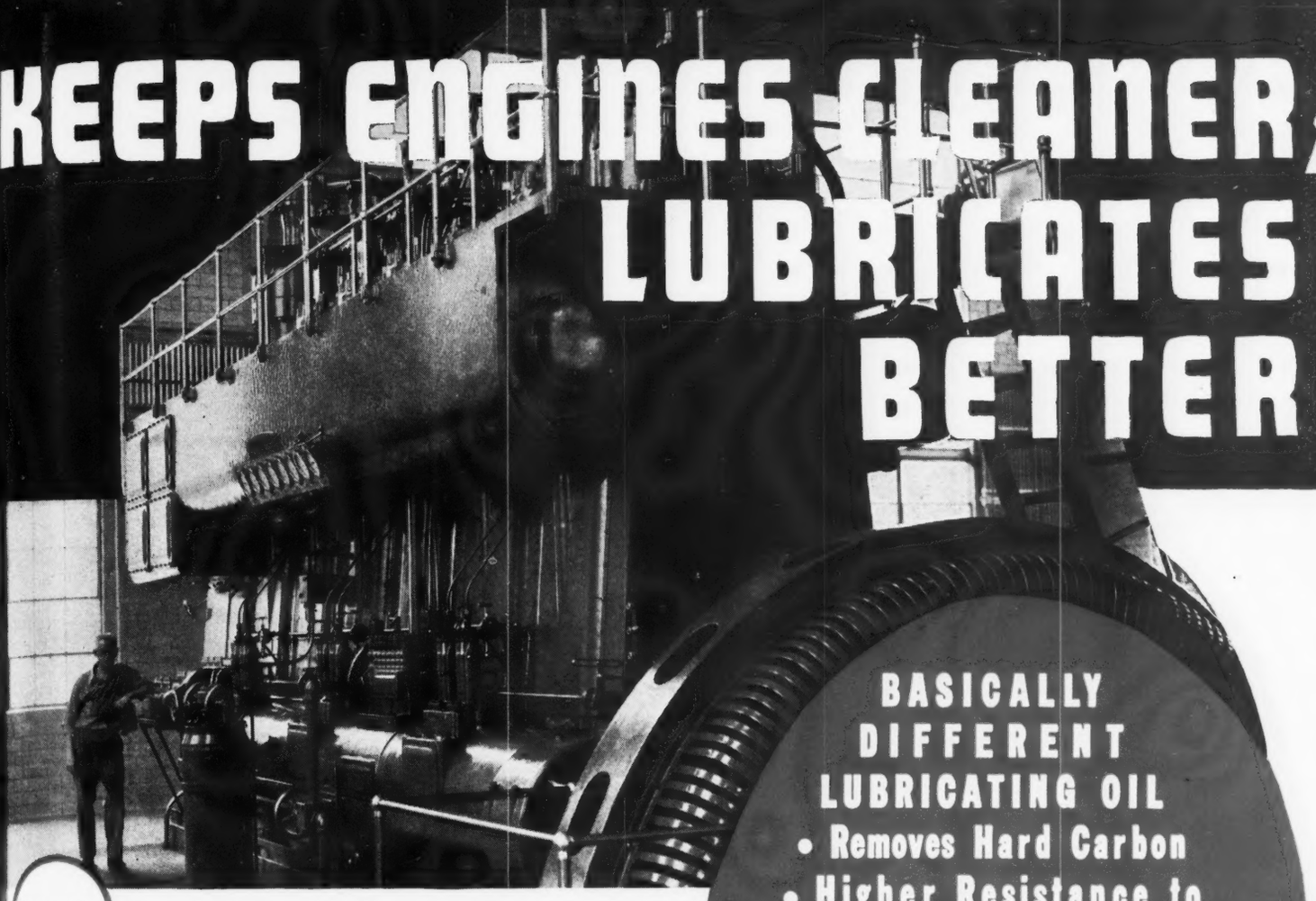
Coventry, England F L BERRY

Avoiding Gas-Fired Furnace Explosions

MY CONTENTION has always been that the greatest single factor entering into furnace explosions is the human element. Boilers, of course, must be designed as far as possible to eliminate pockets in the setting which might trap unburned gas. As far as automatic safety devices go, we in our plant have none, but depend on the operator.

When the plant was first started, con-

KEEPS ENGINES CLEANER; LUBRICATES BETTER



BASICALLY DIFFERENT LUBRICATING OIL
- Removes Hard Carbon
- Higher Resistance to Heat and Oxidation
- Non Corrosive • 3 to 10 Times Stronger Protective Film.

ADDS POWER • SAVES WEAR SAVES FUEL • SAVES SHUT-DOWN TIME

LION
Naturalube
MOTOR OIL and *DIESEL AND HEAVY DUTY OIL

If you're an engineer in charge of a power plant, you know a lot about lubricating oils. But have you tested Lion Naturalube — the basically different lubricating oil? Are you not interested in an oil that assures "bonus" performance by stepping-up horsepower, lowering fuel consumption and reducing wear?

These statements are not hard to accept when you consider Naturalube's basically different properties. Naturalube's solvent and penetrative properties conserve power by removing hard carbon from pistons, rings and valves. In addition, Naturalube's 3 to 10 times stronger film safeguards the engine even while operating under heavy loads and extreme operating temperatures. And furthermore, Naturalube is non-corrosive and is highly resistant to heat and oxidation. Try Naturalube . . . compare it with conventional oils . . . then you will agree that Naturalube is better fitted for economical, dependable engine operation.

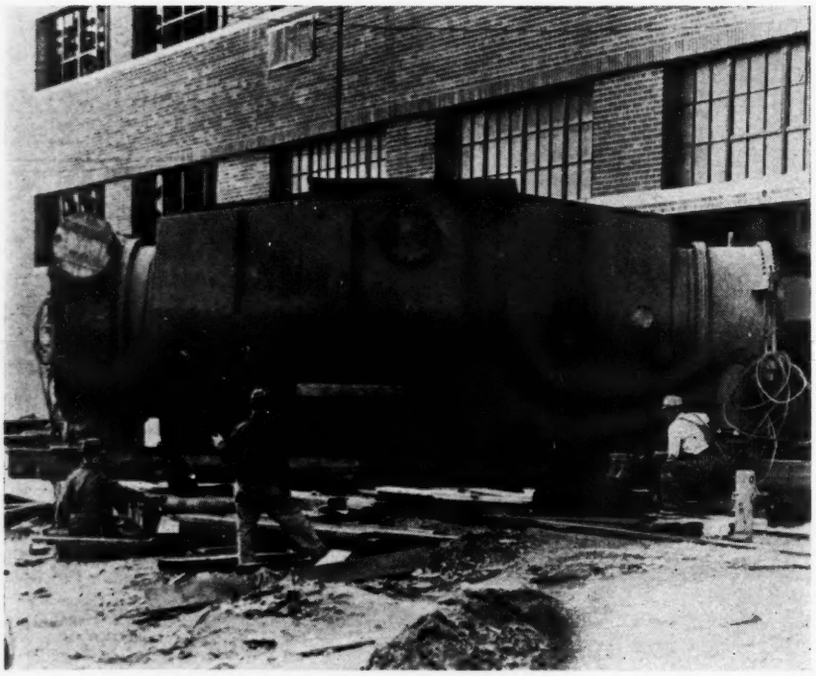
**Naturalube Diesel and Heavy Duty Oil is specially fortified or reinforced to resist the effects of intensified heat and oxidation under extreme conditions. Engines constantly operated at high speeds and/or heavy loads need this super lubricant.*

For visible proof of Naturalube's money-saving properties and details of money-back guarantee phone the nearest Lion Naturalube dealer or write Lion Oil Refining Company, El Dorado, Arkansas.

Made By LION OIL REFINING CO., El Dorado, Ark.

LION PETROLEUM PRODUCTS

ANOTHER NEW ONE GOING IN



The above unit was bought on open, fair competitive bids.

The entire work was subject to inspection by a noted inspection organization.

This condenser and steam jets exceeded their performance guarantees.

The delivery was ahead of schedule.

The installation was ahead of schedule.

The condenser and air jets were designed and manufactured, installed and placed in operation by us.

By the way, we still must dispose of units taken in trade. See the "Searchlight Section".

CONDENSER SERVICE & ENG. CO. INC.

310 TWELFTH ST. HOBOKEN, N. J.

siderable care was used in the selection of engineers. Men in the neighborhood of 50 years old were selected, men with years of experience, of the highest character and thoroughly reliable. Carefully trained and impressed with the ever-present danger of furnace explosions, these men took their responsibilities seriously. Consequently, the power-plant personnel has not been changed in the two years the plant has operated and to date there has never been a furnace explosion or even a flareback.

If care is not taken, there may be greater danger of explosion in a dead boiler than one in operation. It is so easy to consider a dead boiler as having no potential hazard. Any possible chance of gas leaking into such a boiler must be eliminated. The system we use is to shut off the gas header that feeds the burners and leave purge cocks on this header open to atmosphere.

Another danger point is in starting up the boiler. We open the damper wide for at least five minutes to allow air to circulate through the setting before starting a burner; this cleans any possible gas pockets that may have collected.

In actual operation, we carry higher CO_2 in the flue gas than do most gas-fired plants. Boiler control is adjusted to give almost 10% CO_2. As 11.7% is ultimate with the gas we use, this 10% is about as high as good operating practice will allow. Occasional checks with a hand orsat never show more than a slight trace of CO and usually none whatever. Many gas-fired plants do not try to carry more than 9% CO_2 and claim 10% cones in the danger zone. All I can answer to that is to point to our past explosion-free operation, which should be at least partial proof.

Another thing that is still part of the human element enters into the danger of furnace explosions. This is carelessness. I do not mean carelessness in the usual sense of the word, but carelessness that comes from months of trouble-free operation, which may lull an operator into a false sense of security. This might cause him to short cut or neglect some seemingly minor detail.

Every effort was made on our part at the start to instill in the mind of each operator a good healthy respect for the fuel he was burning without giving him a fear of it, which would make him useless as an operator. Now the only problem is to keep that respect alive so there is no letdown in the attention to detail.

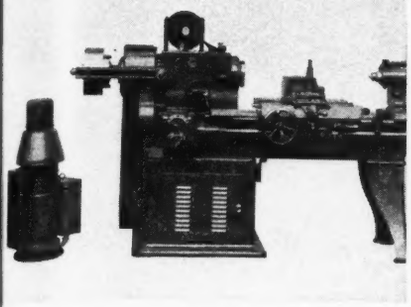
Rochester, N. Y. H P KING

Answers to WHO IS DOING WHAT *with*

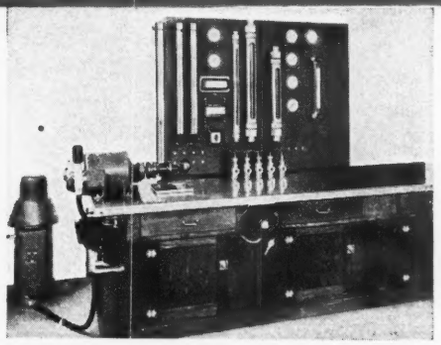
RELIANCE V*S DRIVE

AN ALL-ELECTRIC ADJUSTABLE-SPEED DRIVE FOR A-C. CIRCUITS

SPEED RANGES UP TO 12 TO 1
SIZES 1 TO 15 HP.



LATHE: A lathe builder gives machine-tool users something really new in this machine designed to make full use of the advantages offered by the Reliance V*S Drive.

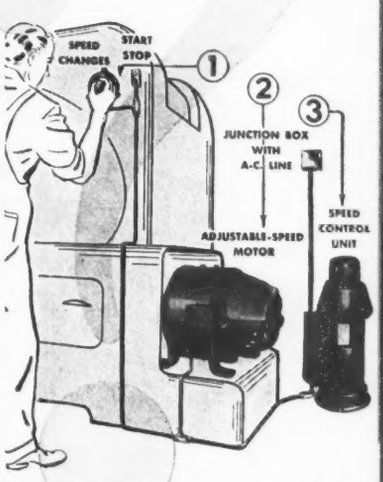


TEST BENCH: Air transport companies use test benches like this to put pumps, magnetos, and generators through rigorous tests. Speeds range from 100 to 4200 rpm.

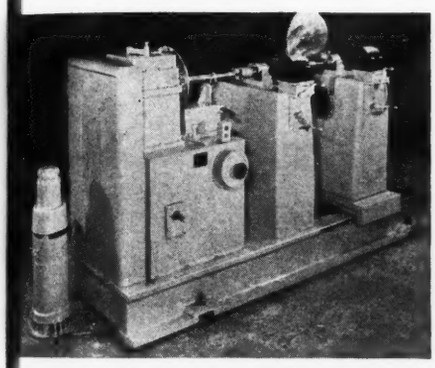
1. REMOTE CONTROL
Starting, stopping and speed changing are controlled from any point to which a wire can be run.

2. A SPACE-SAVER
Power is applied where you want it without an intervening speed-changing device.

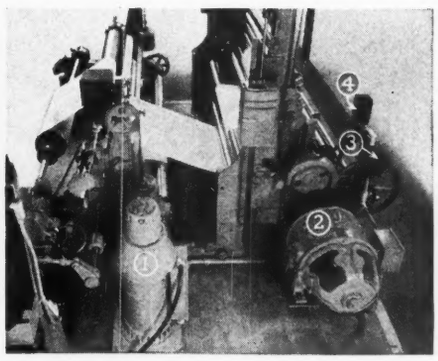
3. FROM A-C. SUPPLY
The advantages of this drive are now made possible at a new low price by the "packaged" V*S Speed Control Unit, connected by three wires to the 3-phase a-c. power circuit; it can be mounted anywhere.



ALSO—Quick stopping, speed setting, reversing, safe speeds for threading and inching, ample starting torque for all conditions. Write for Bulletin 307.

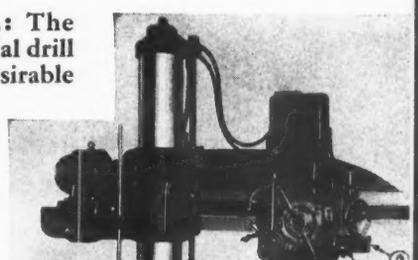


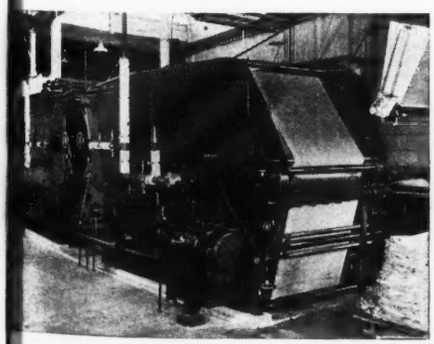
BALANCING MACHINE: An engine builder uses a V*S Drive on this machine designed for balancing propellers. A turn of a handle gives smooth changes in speed over a wide range.



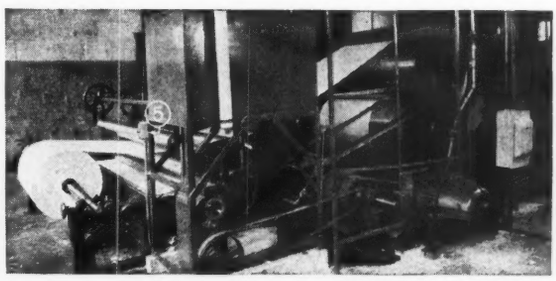
WINDER: A manufacturer of winders uses a 7½ hp. 1150/148 rpm. drive. Gets a low speed for threading and a top speed for the highest rate at which the roll can be wound.

RADIAL DRILL: The buyer of this radial drill gets all the desirable features of an easily-controlled adjustable-speed drive because the builder equipped it with a 7½ hp. V*S Drive. ➤➤

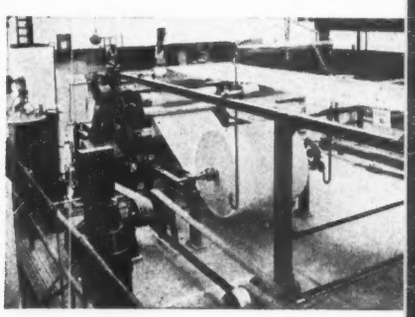




SANFORIZER: Makers of processing equipment such as this Sanforizer use the V*S Drive because it provides the desired operating speeds to suit a variety of materials. Also because it's easy to control starting, stopping and speed changing at points remote from the driving units.



WAXING MACHINE: A waxing machine manufacturer added buying appeal to his machine by using a 15 hp. 1750/218 rpm. V*S Drive. Waxing is done at higher speeds; smooth acceleration eliminates paper breaks.



LAMINATING MACHINE: A fibreboard plant uses a 15 hp. 700/87 rpm. drive for a laminating machine.

RELIANCE ELECTRIC & ENGINEERING COMPANY
1075 IVANHOE ROAD • CLEVELAND, OHIO

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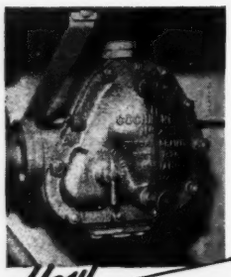
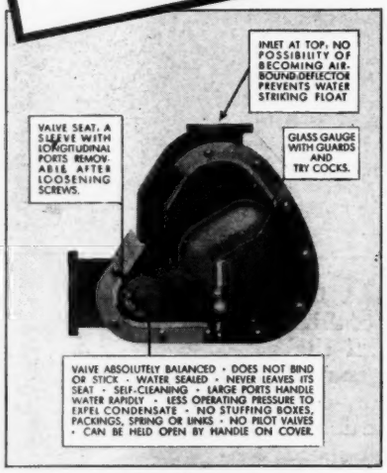
PITTSBURGH • PORTLAND (ORE.)
ST. LOUIS • SAN FRANCISCO • SYRACUSE
(N. Y.) AND OTHER PRINCIPAL CITIES

RELIANCE A-C D-C MOTORS



How COCHRANE MULTIPORT DRAINER permits Quick drainage of Large Quantities of condensate


INLET AT TOP: NO POSSIBILITY OF BECOMING AIR-BOUND. DEFLECTOR PREVENTS WATER STRIKING FLOAT
VALVE SEAT, A SLEEVE WITH LONGITUDINAL PORTS, REMOVABLE AFTER LOOSENING SCREWS.
GLASS GAUGE WITH GUARDS AND TRY COCKS.
VALVE ABSOLUTELY BALANCED · DOES NOT BIND OR STICK · WATER SEALED · NEVER LEAVES ITS SEAT · SELF-CLEANING · LARGE PORTS HANDLE WATER RAPIDLY · LESS OPERATING PRESSURE TO EXPEL CONDENSATE · NO STUFFING BOXES, PACKINGS, SPRING OR LINKS · NO PILOT VALVES · CAN BE HELD OPEN BY HANDLE ON COVER.

THE "Multiport" principle on which Cochrane Drainers operate is that of a hollow cylindrical valve with a number of longitudinal ports which register with similar ports in the valve seat when the float is in the raised position. The combined capacity of these ports is unusually large which accounts for the valve's extraordinary discharge capacity. Mail this coupon today—

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Connects Valve to Full Oil Tank

THE FIGURE SHOWS how we attached a valve to a large oil tank without removing the oil. This job was done in South America where it was not possible to get enough tank cars to serve as temporary reservoirs.

First, we located the center of the hole and drilled a 1-in. hole partly through the plate to act as a guide. We then centered a flange on a short section of pipe around the drilled hole and electric welded it into place. The flange welded to the tank had to be without bolt holes, so we cut one from a piece of steel plate and welded it to the pipe section.

From a section of 5-in. steel pipe, we made a special circular cutter, which we welded to a heavy steel disk. This disk was made larger in diameter than the cutter to prevent it from going through the hole after it had cut through the plate. We case-hardened the cutter and welded a section of 1¾-in. steel shafting to the center of the disk with which to operate the cutter.

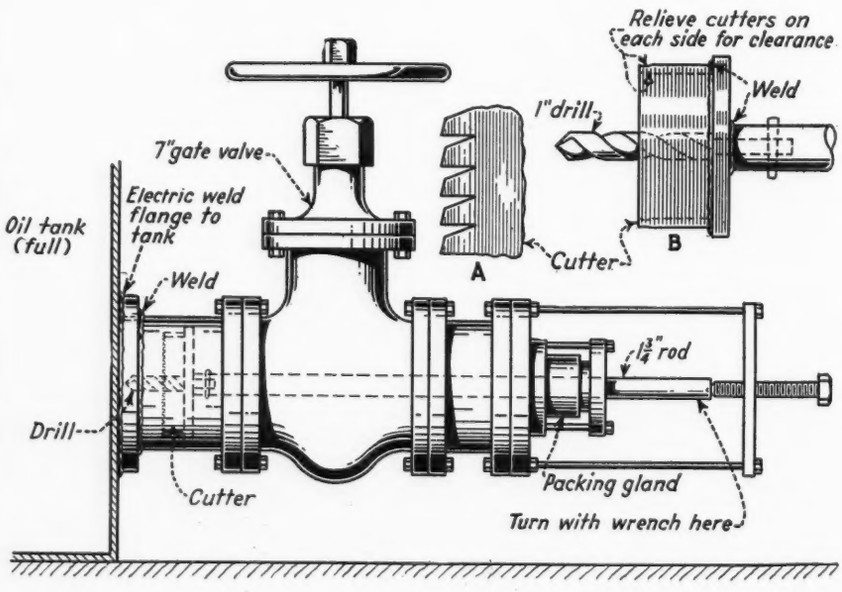
In the center of the cutter and shaft we drilled a hole for the shank of the 1-in. drill and fastened it in place by two pins at right angles to each other. A special flange with a packing gland and a driving head was built. Then the gate valve and another short section of pipe were put into place. The closing head with the cutter in place was then installed and we were ready for business.

As the cutter was moved toward the plate by the driving screw it was turned with a wrench on the shaft. First, the 1-in. hole through the plate was completed and then with the drill acting as a guide for the cutter the large hole was cut. When the cutting was complete the oil pressure in the tank forced the circular piece of plate into the cutter. Then the cutter was pulled back through the valve and the valve closed, the cutter head removed and the remainder of the pipe installed. No trouble was experienced in doing the job and the work was completed in a comparatively short time.

Battle Creek, Mich.

C A VAN DEURSEN

Check Lube System on New Turbines

BEFORE STARTING A NEW TURBINE or one that has been shut down for a long time, it is very important that the lubrication system be scrupulously cleaned before filling it with oil. With a new turbine drain the oil completely after 300 hours of operation and then clean the oiling system thoroughly before refilling.

At least annually, the oiling system should be carefully inspected and thoroughly cleaned. The oil cooler, piping, bearings and other parts should be disassembled and cleaned. Reservoirs and settling tanks should be hosed out with hot water or steam and wiped clean and dry. Use linen rags as cotton waste and other rags leave fluff and lint. If the cooler cannot be cleaned with hot water or steam, immerse it in a cleaning solution consisting of 4 oz each of trisodium phosphate and soda ash, dissolved in 1 gal of water.—*From Bulletin of Virginia Polytechnic Institute, Vol 33, No 14, August, 1940.*